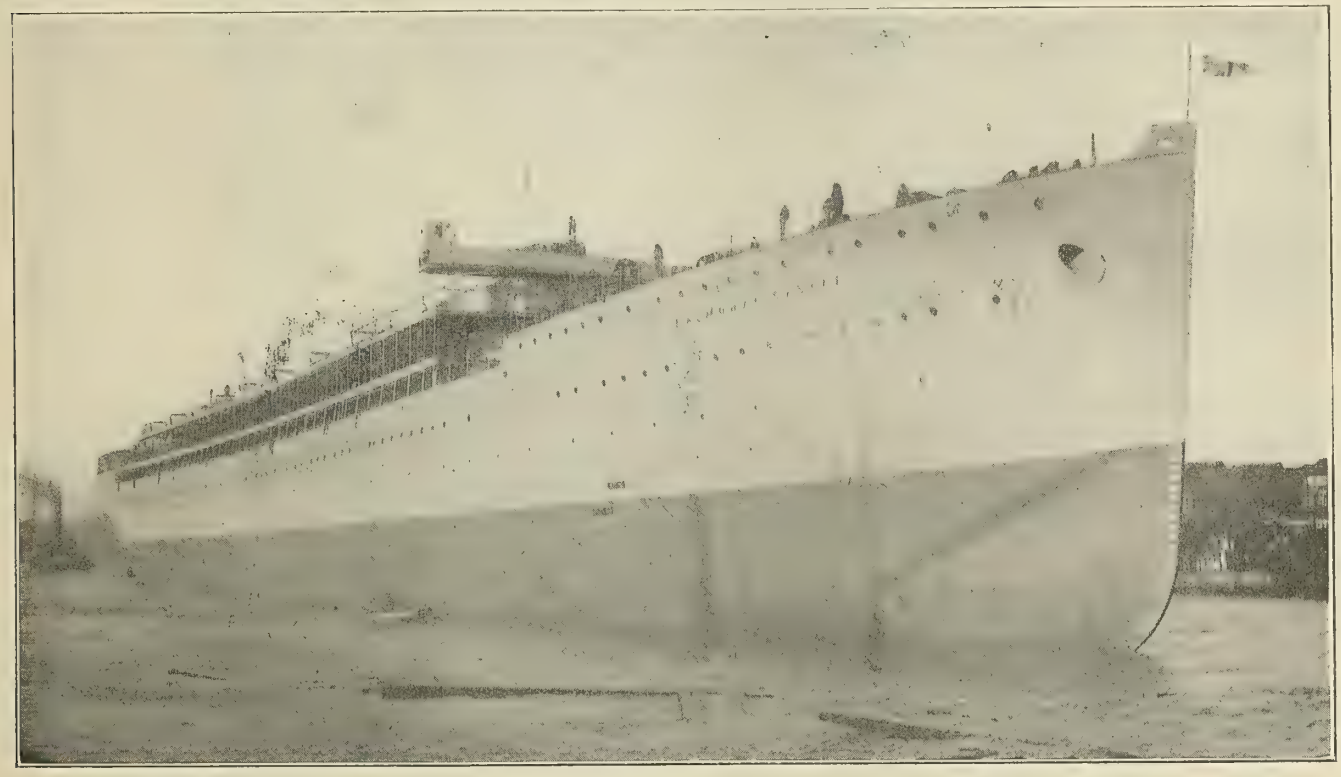
INDEXED.

# International Marine Engineering

FEBRUARY, 1910.

## THE NEW CASTLE LINER BALMORAL CASTLE.

The Union-Castle Mail Steamship Company's new liner, *Balmoral Castle,* of 13,000 tons gross, was constructed at the Govan shipyard of the Fairfield Shipbuilding & Engineering Company, Glasgow, and was launched on Nov. 13, 1909. The new steamer is fitted with quadruple-expansion riciprocating engines, which drive two propellers, and she has been built to the rules of Lloyd's Register for the highest classification of that society. Her principal particulars may be given for clearness in tabulated form as follows:



THE NEW 13,000-TON UNION-CASTLE MAIL LINER, BUILT BY THE FAIRFIELD SHIPBUILDING & ENGINEERING COMPANY.

| | |
|---|---|
| Length over all | 590 ft. 9 ins. |
| Length between perpendiculars | 570 ft. |
| Breadth, extreme | 64 ft. 6½ ins. |
| Depth, molded | 42 ft. 6 ins. |
| Mean service draft | 26 ft. |
| Mean service displacement | 17,500 |
| Indicated horsepower | 12,500 |
| Speed at sea | 17 knots. |
| Tonnage, gross | 13,000 |
| Number of first class passengers | 320 |
| Number of second class passengers | 220 |
| Number of third class passengers | 270 |

The hull is divided into separate watertight compartments by nine bulkheads. To further insure immunity from danger, a double bottom is fitted all fore and aft, divided by watertight floors into separate water-ballast tanks. Each tank can be filled or emptied independently, so that the trim and draft of the ship can be adjusted at any time to suit the conditions of service.

The propelling machinery of the *Balmoral Castle* consists of two sets of quadruple-expansion engines of the latest type. These engines embody all the latest improvements, including balancing on the Schlick-Tweedy principle. Special attention has been paid to this feature in the design, the position of the cylinders and the crank angles being arranged so as to ensure that vibration will be practically non-existent. The dimensions of the cylinders are as follows: High-pressure cylinder 32 inches diameter, second intermediate-pressure cylinder 66½ inches diameter, low-pressure cylinder 96 inches diameter, the first intermediate-pressure cylinder 46 inches in diameter; they are placed in the order named, reading from forward to aft. The stroke common to all cylinders is 60 inches. The valves admitting steam to the high-pressure and first mean-pressure cylinders are of the piston type, while those to the second mean-pressure and the low-pressure cylinders are the ordinary flat slide valves. The valve gear is of the usual link-motion type, controlled by a double-cylinder "all-round" type reversing engine.

The crankshafts are of the built-up type, and are 19 inches diameter in the journals. The crankshaft for each engine is in four separate sections, and is carried in eight bearings in the bedplate, the bearings being lined with white metal. The whole of the shafting is of solid ingot steel.

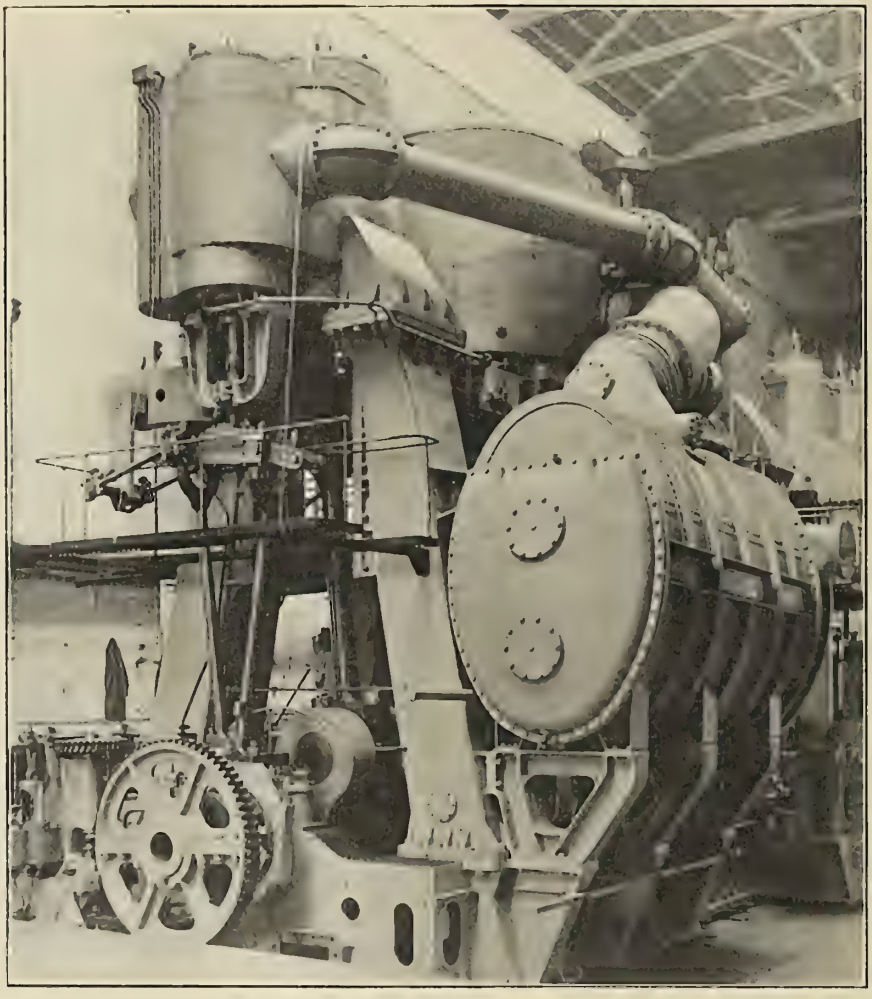
The condensers are of the ordinary type, and are supported on brackets attached to the back columns of the main engines. The total condensing surface for both engines is 17,000 square feet. The condensed water is discharged from these into a hot-well tank at a temperature of about 100 degrees F.

There are two propellers, each having four blades of manganese bronze, bolted to cast steel bosses.

The boilers, ten in number, six of which are double ended and four single ended, are arranged in two groups in separate boiler rooms. The double-ended boilers have each six furnaces, and the single-ended boilers have each four furnaces, making a total of fifty-two furnaces. The products of combustion are led into two funnels of oval form. The furnaces are of the corrugated type. The total heating surface is 40,780 square feet, and the working pressure 220 pounds per square inch. All the furnaces are worked under natural draft, but fans have been provided for ventilating the stokeholds.

The auxiliary machinery, in the way of pumps, filters, heaters, evaporators, etc., is of a very complete and up-to-date character. There are four Weir's boiler-feed pumps, arranged in pairs. Each pair is controlled by a Weir float-control tank, having a cross-connecting pipe, so that any pump can be controlled by either control tank. These pumps draw from hot wells through two independent sets of List & Mun's patent filters, and discharge through a Quiggins heater, or direct to boilers, as required. There is also in each boiler room one of Weir's auxiliary feed pumps, having the same connections as the main pumps and controlled by each float tank. These are for feeding the boilers while in port. The main circulating pumps are of the *Bon Accord* centrifugal type, by Messrs. Drysdale & Company, Glasgow, and of ample size to ensure an efficient vacuum under all conditions. These circulate the water through the main condensers, the outlet water being discharged below the light-load line. Each circulating pump is arranged to draw from the engine-room bilge through separate valves, each 18 inches diameter, in the event of a serious leak taking place in the ship.

The ballast pump is of Messrs. H. Watson & Company's Westminster type; the pump barrel, bucket, valve boxes, etc., are of gunmetal. The pump is connected to the bilge main, the engine-room bilge direct, and to the ballast tanks, and discharges overboard through the port main condenser or through the distilling condensers. There are three vertical duplex pumps, made by Messrs. J. H. Carruthers & Company, for general service, for supplying salt water, for fire service, for sanitary service, and for hot and cold salt-water baths, of which there is a large number on board, the water for hot baths being discharged through a large tank, which is heated by steam coils. These pumps are arranged to work independently of each other, so that they can be used at the same time on separate services.



ONE OF THE QUADRUPLE-EXPANSION ENGINES OF THE BALMORAL CASTLE.

The evaporator plant consists of two Quiggins evaporators, each of 40 tons capacity per twenty-four hours; two Quiggins distillers and filters, each of 6,000 gallons per twenty-four hours; one vertical pump for feeding evaporators, and one pump for brining evaporators. The evaporators are connected to the main condensers for making up feed water, and to the distillers for making drinking water.

The auxiliary condensing plant for use in port is capable of dealing with the exhaust steam from all the auxiliary machinery. It consists of a condenser, a centrifugal pumping engine and one of Lamont's patent double-bucket air pumps, with one steam cylinder. The water from the auxiliary condenser drains to a collecting tank, and then overflows to the feed filter and feed pump. There is one vertical duplex steam pump of Messrs. Carruthers' make, drawing from fresh-water tanks in the double bottom and discharging into service tanks on deck for ship's use. This pump is controlled by a separate float tank.

At the forward end of the shaft tunnels there is an enclosed steam engine driving a fan, which draws fresh air through a trunk from the top deck for ventilating the tunnels.

In each boiler room there is a boiler-circulating and ash-ejector pump, of the vertical duplex type, made by Messrs. Carruthers. There are two See's ash ejectors, one in each boiler room. Two ash hoists and engines are fitted for raising ashes while the ship is lying in port.

The electric generating plant consists of three sets, manufactured by Messrs. Allen, of Bedford. Each set embodies a compound-wound dynamo, directly coupled to a high-speed engine, and is constructed for a continuous output of 75 kilowatts at 100 volts when running at a speed of 265 revolutions per minute. The engines are of the vertical, enclosed, double-acting two-crank type. Each has one high-pressure cylinder, 9 inches diameter, and one low-pressure cylinder, 15 inches diameter, the stroke being 9 inches.

The steam steering machinery is Messrs. Brown Bros.' patent tiller gear, with emergency gear alongside, both of these being controlled from the forward or after bridge by telemotor gear. The rudder head is 15 inches diameter, and the rudder is of the single-plate type, having a horizontal coupling. The thickness of the rudder plate is 25/20 inch. Two powerful warping capstans are fitted alongside the steering house aft on the promenade deck.

The *Balmoral Castle* has six decks, named in the following order from below: Orlop, lower, main, upper, promenade and boat deck. The ship has two oval funnels and two pole masts, with seven derricks for working cargo.

On the promenade deck, amidships, is the first class entrance and lounge. In the center of this room there is a large well over the first class dining saloon. The lounge is handsomely furnished with small tables, easy chairs and settees, also a grand piano. At the aft end of the lounge is the first class library. Forward of the lounge there is a house containing a number of first-cabin staterooms. On the promenade deck 'midships there are several second-saloon staterooms, also the Doctor's and purser's rooms. Aft of these rooms there is the second class entrance, which leads to the second class library. The promenade deck aft is reserved for third class passengers, and here is placed the third class entrance and lounge and third class smoke room.

Below the promenade deck, and on the upper deck leading from the main entrance, there is the first class dining saloon. This room, which is placed about midway between the funnels, does not extend to the ship's side, but is enclosed in a very broad deck house. In the center of the room there are two long tables, and on each side six small tables. The saloon is arranged to seat 182 persons, and it is well lit by the large dome in the center. At the fore end of the room there is a piano and an organ, and at the after end an artistic sideboard. Forward of the dining saloon there are first class staterooms. Aft of this saloon are the pantries, with the sculleries, galleys, bakeries, confectionery, etc., forming one large kitchen, and equipped with all the most up-to-date machinery and appliances for cooking.

Aft of the pantries is situated the second class dining saloon. In the center are the usual long tables, and at the sides a number of tables, each to seat ten persons. Dining accommodation is provided for 162 passengers. At the aft end of the room there is a piano, and at the forward end and artistic sideboard. This saloon, like the first class saloon, does not extend to the ship's side, and is placed at the aft end of the steel deck house.

On the upper deck aft, near the stern, is the third class dining saloon, which extends the full breadth of ship, with a bulkhead at both ends and an entrance in each bulkhead. Seating accommodation is provided for 162 passengers. There is also a pantry and bar near the saloon and a dispensary and hairdresser's shop. Aft of the third class saloon a number of third class cabins are fitted, with lavatories and bathrooms

Leaving the upper deck and going below, the main deck is reached. With the exception of the fore end this deck is all occupied by two and three or four-berth cabins for first, second and third class passengers. There is a large number of bathrooms and lavatories situated in convenient positions throughout the deck.

The lower deck is all cargo space, part of it being insulated for carrying frozen meat. Under the lower deck is the ship's hold. On the boat deck, forward, is the officers' house. Between the funnels the first class smoke-room is placed, and at the aft end of the deck there is the second class smoke-room. A wireless telegraph office is situated abaft the second funnel. On this deck there are sixteen boats, each carried in Welin's quadrant davits.

For working the anchors and cables there is placed on the forecastle deck a very powerful steam windlass, with two capstans made by Napier, of Glasgow, to work 3-inch stud link cables. For working cargo the vessel is equipped with ten powerful horizontal steam winches, having cylinders 7 inches diameter by 12-inch stroke, and fitted with special heavy reversing gear, the lifting capacity being 4 tons each.

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## MACHINERY AND PIPING ARRANGEMENTS—IV.

BY JOHN M'COLL.

### SUCTION AND DISCHARGE SYSTEMS.

When the auxiliaries of a vessel are to be placed along the shipside, care has to be taken in arranging these so that the shipside suction valves and cocks can be put in convenient positions. They should be easily accessible at all time, and if below the floor-plate level should have extended spindles to bring the wheels or handles above the platform.

The suction valve for the main circulating pump is usually placed low down on the turn of the bilge. It should not be placed on the flat of the ship's bottom, as in the event of the ship touching on a sand or mud bank the aperture would probably fill up, rendering the pump useless. Neither should it be placed high upon the ship side, but rather kept well below the light-load line, so that it will be beneath the surface in any condition of trim or kind of weather. In some ships which have to pass over shifting sand banks in their ordinary trade route, an auxiliary inlet valve is fitted above the main for use should the main be in danger of filling up. It may happen that the best, or perhaps the only place, to put the main inlet valve, would be in way of the bilge keel. In that case the keel should be cut if it would tend to hamper the easy inward flow of water, say when the ship was rolling. Fig. 18 shows how the keel may be cut to prevent ropes, or other gear, getting foul of the cut ends.

The main circulating inlet valves are always made screw-lifting; they should be made also in common with other large valves, to offer the minimum resistance when lifted, or open, to the inflow of the water. The valve chests can usually be

reduced in bulk, if attention is given to this point, when they are being designed. It is sometimes an advantage to have the lower part with the grating made separate from the valve chest proper. The area through the grating to the area of the pipe in sea-suction chests varies in different services from 1.5 to 1 up to 2 to 1. In ordinary merchant service the proportion adopted is one and a half times the area of the pipe.

If the vessel is to sail where the aperture may be closed with ice or weeds, a stop valve with a connection to the auxiliary steam system is fitted to the sea side of the valve chest; these valves are from ¾ inch to 1 inch diameter for the larger chests.

The circulating pump has to draw from the bilge. The bilge valve is usually joined for convenience to the sea valve, and as the bilge valve *may* have an important part to play in the emergency for which it is provided, attention should be given to the following points: The handle or wheel should

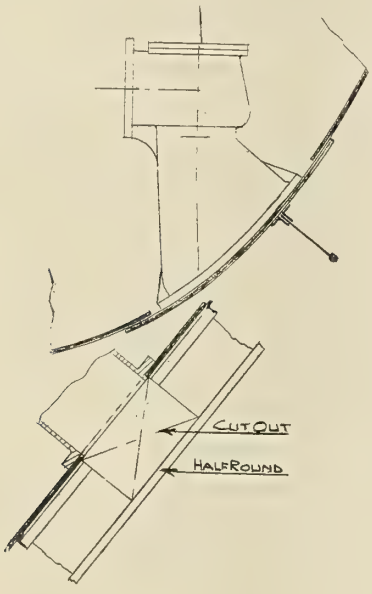



FIG. 18.

be about 3 feet above the floor plates, so should the handle for the sea valve, that these may not be submerged should the water rise to or cover the platform. The valve must always be non-return, and should, when over 6-inch bore, be made of the rubber and guard type, as a brass valve over 6-inch bore has considerable weight, and would be a hindrance to the pump. The pipe from the valve to the bilge should be closed at the end, but perforated with small holes of ample total area, or the end of the pipe may be open, but boxed in with perforated plates. The bore of the bilge pipe is made two-thirds of that from the sea.

If the circulating pump is of the centrifugal type a small air cock with a pipe to the bilge should be fitted to the highest part of the pump casing.

If the smaller pumps are required to have separate sea-suction valves, these may be grouped on one stalk, or grating bore, so that fewer holes need be cut in ship side.

The main circulating overboard discharge valve may be placed above or below the load waterline. In yachts, and in some passenger steamers, the discharge valves are placed below the load waterline, as this prevents the discharged water being flown into spray, and onto the decks, to the discomfort of guests or passengers. All discharge valves may be below the load waterline except that for the air pump, should one be fitted. The usual type of valve for discharge is the L or angle type, non-return, with a cast iron weight on top of the spindle. If the distance between the valve and the deck above it is restricted, the through type of chest may be used, having the spindle and weight on the bottom side of the chest, and leaving just sufficient space below the deck for the valve to be withdrawn from above. As the valves are usually a considerabe height from the platform, means have to be provided for raising and keeping them open; this may be simply done by attaching to the weight a thin wire rope, passing it over a light pulley and down to the platform. If the valves are in an easy accessible recess, some simple device need only be provided for keeping them open. Where cocks are fitted to the ship side for, say, the boiler blow-off to sea, provision is made that the key or handle can be withdrawn only when the cock is closed. But as in the steam and exhaust system, cocks should not be used on the ship side if valves will suit.

When the air pumps are of the independent type, the suction pipe from condenser to pump should be made without pockets or sharp bends, and be as straight or direct as possible. The overflow pipe, on the discharge side, if not led overboard, should be carried high up, and turned down in such a direction as will prevent the overflow water falling into a passage or on men working near.

The feed pumps may draw from the hot well, direct, without requiring spceial arrangements being made, but if there is a graviation filter between hot well and pumps, their respective levels have to be considered. The water should *flow* from the hot well to the filter, and from the filter to the suction valves in the pump. In other words, the suction valves are lower than the filter outlet, and the filter inlet lower than the hot well, and to ensure that the pumps do not draw through the filters, a by-pass is fitted on the filter, that it may be cut out for cleaning or overhaul, if required.

If a float tank is fitted, it is placed as near the center line of the ship as possible to minimize the disturbance due to rolling; and in twin-screw vessels, means should be taken to prevent the water flowing freely across from one pump or filter to the other under the same conditions. The feed pumps should not draw from the bilges, nor should other pumps which may be required to feed the boilers, be connected to the bilge system, if sufficient provision can be made for bilge service otherwise. On the discharge side of the feed pumps the pipes should always be kept above the floor. Where branch pieces are used these should be of Y rather than T-shape. Although cast iron is sometimes used for feed branch pieces, gunmetal is preferred, as being better able to withstand such shocks as they are liable to. They should be strengthened with ribs, and the body of the piece, where it joins the flange, should be gradually thickened up to meet the flange.

On long lengths of discharge piping, provision must be made for expansion, and all bends should be of large radius. They are better carried along the bulkheads and bunkersides, instead of across the front of the boilers, as they can be well supported, and are out of the way of gage glasses, etc. Copper is the material usually employed for feed pipes, but solid-drawn steel is coming into favor for the same reasons as given for their preference in steam systems.

The positions of the check valves on the boilers will depend on the arrangement, but generally they are better to be high up than low down, and on the ends of the boilers than on the sides.

If the filter is on the discharge side of the pump it is required to have an escape valve, and should have a pressure gage fitted between the pump and filter. Both the feed heater and filter should have by-pass valves, to enable them to be overhauled or examined without interrruption to the feed

supply. The auxiliary feed discharge need not pass through the filter or heater, unless specially specified.

In ships carrying a large number of passengers the fresh-water pump and connections are of much importance. It is usual to have some fresh-water tanks in the double bottom reserved for ship and some for engine use. The suction pipes from each tank will probably join into one main, from which the fresh water and feed pumps draw. Herein lies a source of friction between the engine and ship officers, and an arrangement can and should be made that will prevent either department borrowing from the other without the other's consent. On the discharge side of the fresh-water pump it is advisable to have on the overflow a control that will regulate the pump as required. This is sometimes done by fitting close to the pump a small float tank, into which the overflow water is led and from which the water goes back to the tank from which it was drawn.

The ballast pump usually supplies the circulating water for the distillers, and an auxiliary supply to the refrigerating plant. It serves the auxiliary condenser, and in most cases has a connection to the main condenser, for use should the main circulating pump be stopped or go wrong; this discharge should be as large as the pump can supply.

Pipes below or above the platform should be arranged, if at all possible, to lie only fore and aft, or across the ship. Interlacing pipes are a source of trouble when being fitted, and more so when alterations or repairs are required. Beneath the platform the large pipes are better near the tank top, with the smaller pipes above them. Above the platform the steam and exhaust pipes should be placed so that they are not over the passages; this tends to give the engine room an open and cool appearance. It is sometimes convenient to have two or three pipes in the same vertical plane, supported with hangers, as shown in Fig. 19. If, near bulkheads or casings,

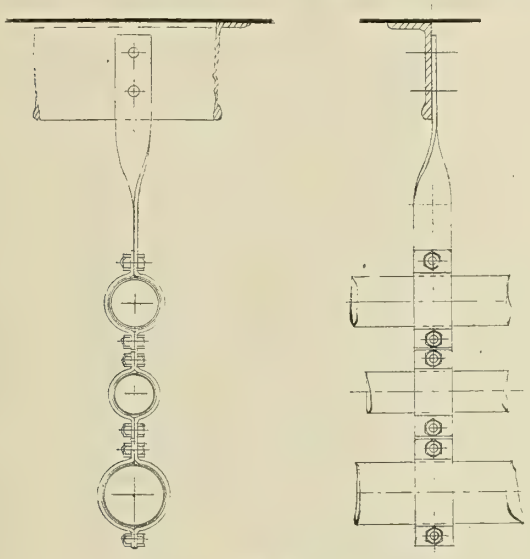


FIG. 19.

pipes should be supported from these, although they may be taken slightly out of their course. Feed discharge pipes especially require to be firmly secured. Light cast iron pipes in straight lengths can be used in discharge services, for ballast and bilge water, for cross connections between circulating pumps in twin-screw engines, and for waste steam leads where these are long; in each case the bends should be of copper. All suction and discharge pipes connected to ship-side valves of cocks should be made of copper, and arranged to take up any slight movement of the ship side without injury to themselves or their connections.

*(To be continued.)*

## ORE-HANDLING EQUIPMENTS FOR LAKE VESSELS.*

BY RICHARD B. SHERIDAN.

In a commercial sense the lakes are scarcely fifty years old, and the growth of the traffic has been little short of marvelous. Iron ore, the commodity which has built up the trade more than any other one substance, was first discovered in the Lake Superior country in 1844 by William Burt and his party of surveyors. On August 14, 1855, the first cargo of ore was carried down the lakes from the mining district. This memorable shipment was taken by the brig *Columbia,* and amounted to 114 tons. The entire shipments for the year amounted to 1,449 tons. From this date the trade grew rapidly, but it was not until 1873 that a season's shipment of ore amounted to more than 1,000,000 tons.

### DOCKS.

In the development of this traffic, which was destined to become such a factor in our industrial history, the first step taken by its pioneers was the construction of a loading dock at Marquette. This dock was built in 1860, and it is an interesting fact to note that its form of construction has been the model on which all of the great ore docks of the Northwest have been built. A long line of pockets was built on a dock extending out into the lake and arranged so that boats could be brought alongside for loading. The material was brought over the pockets on railway cars arranged so as to be dumped into the same. Each pocket was equipped with spouts and gates, and of such height as to permit of a slope to the chute, so that the material would run out by gravity. Naturally the first dock was of very limited capacity, but the principle has been the one on which all of these loading docks have been constructed.

These structures have been built, up to the present time, of wood, with spouts and gates made of steel plate, the gates being arranged to be opened and closed by hand power. The principle is simple and very expeditious. Records are given in which boats of over 10,000 capacity have been loaded in as short a time as one hour. One of the largest of these loading docks is 2,100 feet long, with 350 pockets, giving a total capacity of 87,500 tons.

The construction of the docks have, in one way, influenced the construction of the lake vessels. The spouts with which each dock was equipped were located 12 feet apart along the dock side, and on account of this dimension the boats built in the early days had their hatches located 24 feet centers so that every other spout would be in a position for discharging into ships' holds without necessitating the shifting of the boat itself. As the boats became larger, and the automatic-grab buckets came into use, the number of the hatches were increased so as to require less hand trimming of the material in the hold of the boat, and to-day we find the ships equipped with hatches spaced 12 feet centers, this distance being determined by the position of the spouts on the loading docks.

The question of loading, important as it has been, has not, however, been the perplexing factor in the development of the lake traffic. The great and all-important difficulty that had to be met and overcome was the question of dispatch in the unloading of boats in the lower lake ports. Forty years ago the boats were not constructed so as to easily take ore cargoes in their holds, and most of the bulk material, such as coal and ore, was carried in deck loads. Where it was carried in the hold, it was hoisted to the deck by horsepower and dumped into barrows and wheeled ashore. In 1867 the

* Abstract of a paper on "Material Handling Equipments for Lake Vessels," read before the Society of Naval Architects and Marine Engineers, New York, November, 1909.

horsepower was done away with, and a small hoisting engine used in its stead. Little progress was made in any way toward improving these early methods, and it was not until the latter part of the seventies that any mechanical schemes were attempted. In 1879 a machine was constructed in the harbor of Cleveland, but it had so many faults that it could hardly have been called a success, and it was not until 1889 that the first successful unloading machine was developed, and this date marks the beginning of the real and speedy development of material-handing machinery, as well as the improvements in the ship construction of the Great Lakes.

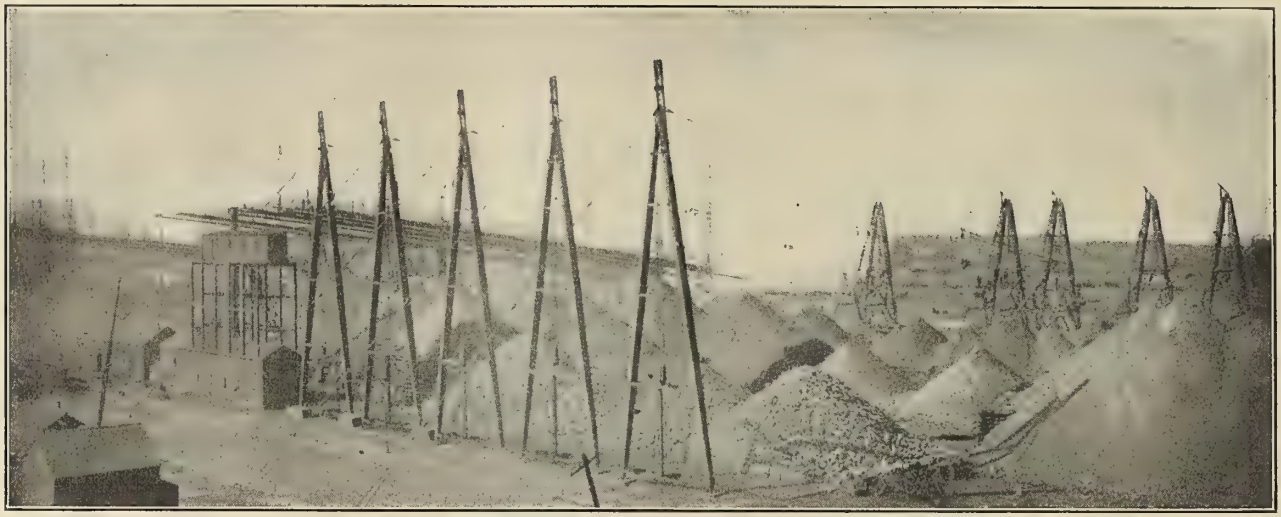


FIG. 1.—BROWN PATENT CABLE TRAMWAY, N. Y., P. & O. R. R., CLEVELAND, OHIO.

FIRST UNLOADING MACHINES.

Many of the various dock managers had been trying every means possible to deposit the ore back from the dock's face by mechanical means. This was first accomplished by a cableway machine, built and erected at Cleveland, Ohio, in 1880, under Mr. Alex. E. Brown's supervision, and with its introduction came the formation of the Brown Hoisting Machinery Company, which has since held such a prominent position among manufacturers.

In Fig. 1 is shown a general view of a plant similar to the first machine erected. Each of the units going to make up the plant of five, consisted of a single rope cable tramway supported by two piers, the one on the dock and the other about 300 feet back from the dock face. The support farthest from the water was A-shape construction and guyed to anchors fixed in the ground. The front support was of special design and mounted on wheels running on two lines of track spaced 24 feet centers.

The front support was arranged on wheels so that the same could be moved a limited distance each side of its normal position, the advantage being to reach every part of the ship's hatch, and also to obviate unnecessary moving of the boat itself. This front pier was arranged to be moved by hand power, and was designed with a portal opening so as to allow railway cars to pass beneath to permit of loading material directly into cars or on to stock pile. This front support was equipped with an arm or apron, which could be housed in a vertical position or lowered down over the boat. The cable was attached to the end of this apron, and when the same was brought to the vertical position, the cable was bent at the hinges and carried on a circular guide, which was concentric with the axis of the hinge of the apron arm. The advantage of this arrangement was that the machine could be operated with the apron in a vertical or horizontal position. On the main cable was designed to run a trolley, arranged to carry a 1-ton ore bucket. The various motions of trolley travel and the raising and lowering of the bucket were controlled through a single drum steam engine, which was located near the rear support.

In Fig. 1 may be seen, at the left-hand side of the five shear-leg supports, the engine house in which were located the five engines controlling the trolleys on the various cableways making up the plant, and the operator for each machine was placed in a small house over the machinery house and at such a height that each operator could easily see and control the trolley on the machine he was operating. The two supports of the cable were of such height as to give a grade in the supporting cable toward the dock face, so that the traveling motion of the trolley when returning empty after discharging a bucket was accomplished by gravity and assisted by a counterweight arrangement acting on the trolley in a direction toward the dock face. By the use of the counterweight, the engine employed was simply a single-drum engine on which was wound a single line. The hoist line of each machine went from the drum on the engine over suitable sheaves to the trolley supporting the bucket, through the trolley, passing down around the hoist block and thence back to the trolley frame, where it was securely fastened.

The buckets were filled by hand in the hold of the boat and then lifted out by the machine and dumped into the storage pile or unloaded directly into cars. The cable was fitted with an up-grade and down-grade stop, the up-grade stop being of such design as to trip the bucket and thereby dump the load. The down-grade stop was simply in the nature of an automatic locking device arranged to hold the trolley still, while the bucket descended into the boat, and when hoisting, to maintain the trolley in the proper position until the bucket was hoisted into the trolley, when automatically the down-grade stop would release, thus allowing the trolley and load to be pulled by the hoisting line up the cable to the dumping stop.

This type of machine was an infinite improvement over the old methods, but it had one fault, and that was, that it could only cover a limited storage pile. The next machines were improved upon, and instead of using the cable type, a structural span bridge of 180 feet in length was employed, and both its supporting piers were mounted on wheels so that the machine could be moved along the full length of the dock.

Fig. 2 gives a general view of a plant of six of these machines. The view is of a plant built of steel throughout, while the first bridges of this type that were constructed were made with many parts of wood. These machines came im-

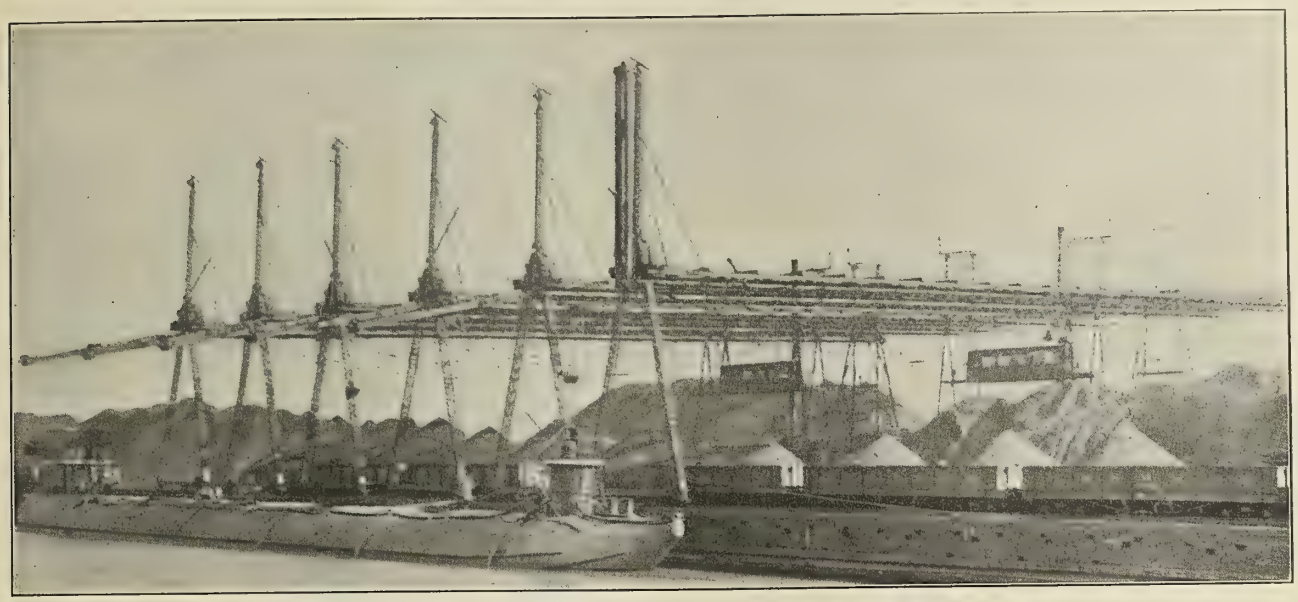


FIG. 2.—TWELVE BRIDGE TRAMWAYS, MENOMINEE DOCK, L. S. & M. S. RY., ASHTABULA, OHIO.

mediately into universal use, and nearly every unloading dock was equipped within a few years. By their use it was possible not only to unload a boat much more rapidly than ever before had been done, but it made it possible to store large quantities of ore. The machines were constructed with a bridge span, and also increased in length by a rear cantilever, so that the ore was stored in two parallel piles, one under the main span, with a capacity of about 220 tons per linear foot, and one under the cantilever projection in the rear with an equal amount per running foot, making a total storage per linear foot along the dock of about 450 tons. The ore was rehandled by the machine out of storage into railway cars.

Although plants of this character proved themselves both time and money-savers, and overcame the great question of handling materials to the stock pile, they did not cut down the cost of filling the buckets in the holds of the boats. This cost varied from year to year, and was largely regulated by the dock labor unions. On an average the filling of the buckets, which was by hand, cost 13 cents per ton, and the cost of handling from boat to dock or stock pile before the time of the unloading machines depended entirely upon how far the ore had to be wheeled, and I am not able to say just how much per ton this averaged. With the introduction of the tramways, however, this work was done for a cost varying from 7/10 cents to 2 cents per gross ton, depending upon how near the machines were worked up to their capacity.

The bridge tramway, as described, came to be an almost universal standard for unloading, but in special cases where cargoes were unloaded directly into railway cars a short plant was often resorted to, and such an equipment is shown in Fig. 3. These equipments were made in batteries of two and four legs. The plant shown is of the two and four-machine unit. All of the operating mechanism was located in one house, and the operators in one cabin, generally situated beneath the machinery house in the manner shown. The main pier, with the machinery and boiler, as well as each of the independent legs, were mounted on wheels, so that they could be moved easily from hatch to hatch along the dock front.

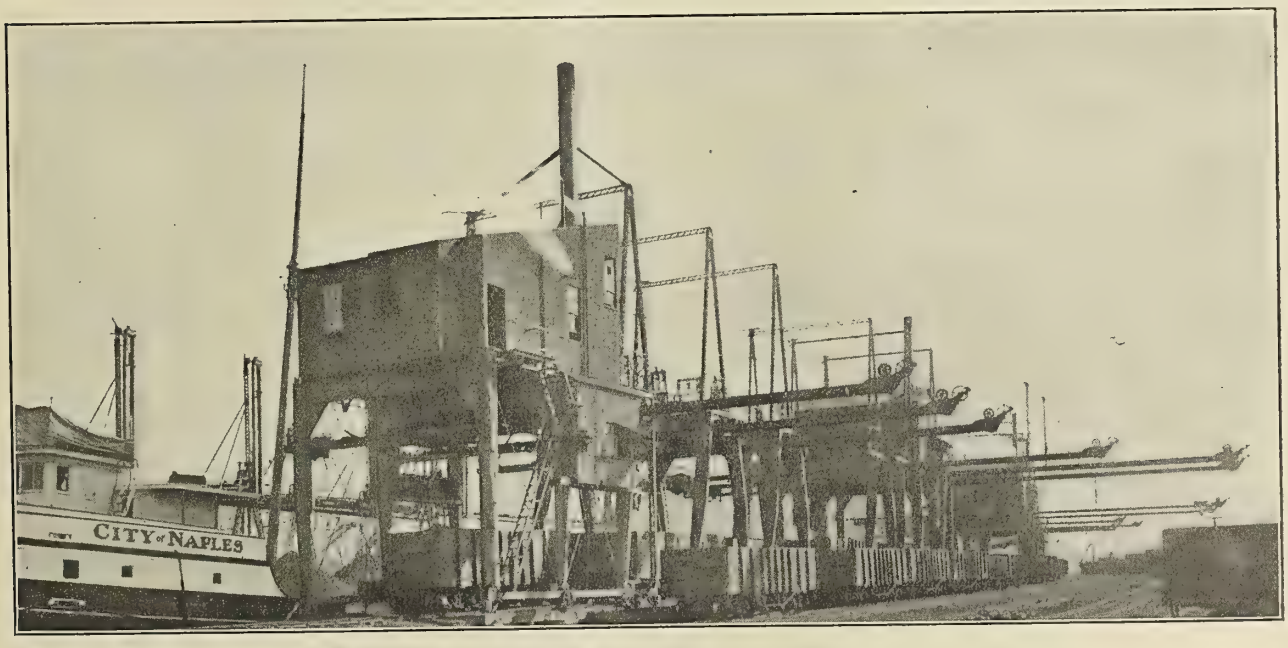



FIG. 3.—TWELVE BROWN HOIST FAST PLANTS, C. & P. DOCK, CLEVELAND, OHIO.

The piers were moved by hand power. The range of working of the farthest independent leg was about 200 feet from the main pier in which the machinery was located.

The machines were made to span two railway tracks and then, by the addition of a rear cantilever, three to four tracks in the rear. These machines, on account of their rapidity, soon received the name of "fast plants," as it was not difficult for them to make from sixty to seventy trips per hour per leg, and this speed was limited largely by the capabilities of the men to fill the buckets.

### ADVENT OF THE GRAB BUCKET.

Both equipments, as outlined above, had served a great want and took care of the tonnage in a very satisfactory manner. The problem of reducing the hand labor in the boats became an important factor, and, for several years before the grab bucket was adopted, attempts were made to work mechanical buckets in coal and similar soft materials. They were found to be very efficient tools and were used in different parts, years before finally adopted for ore. In the early days of the ore trade the majority of the ore brought down from the upper lakes was hard and lumpy, and nothing could be done in it with a mechanical bucket. When the soft Messaba ores began to be used, about twelve years ago, the conditions were such as to allow of a mechanical bucket, and renewed efforts were made to develop this class of tool. About nine years ago the first successful grab bucket equipment was erected in Chicago by the Hoover & Mason Company. This plant consisted of four machines, built along the lines of the short fast plants above described and were arranged to discharge directly into railway cars. The main difference between these, however, and those shown on the fast-plant photograph, was that each machine was a complete plant in itself.

The advent of the grab bucket marked a point of radical change, not only in the design of the plants themselves, but also in the design of the boats. Up to the time of using the grab bucket, the material had been handled in tubs of about 1-ton capacity. This size had been found by experiment to be the most satisfactory for hand filling and handling in the hold of the boats, but with the new mechanical buckets the question of size seemed to be limited only by the dimensions of the hatches and the construction of the holds. The first grabs made to handle ore were made to take about 80 cubic feet or 5 tons, and since that time plants have been equipped with 5, 7½, 10 and 15-ton buckets. The question of what the most economical size should be is still a mooted one, and one which no doubt will be discussed for some time.

### TYPE OF GRABS.

In the development of the grab buckets, the old principle on which the grabs or clamshells employed for so many years in the handling of dirt and other material have been followed out, and consequently the digging power of the bucket depends to a very large extent upon the weight of the bucket itself, and to get a load it is always conceded that the bucket must be dropped as hard as possible to get an entrance into the material. The buckets have been generally of the two-blade type and with smooth cutting edges. The teeth, which have always been thought necessary, especially in handling lumpy material, have been done away with on account of the injury they did to boats. Furthermore, it has been found more advantageous to have the buckets made with smooth blades, to facilitate cleaning up, which could not be done well with buckets having teeth. The graps employed in this traffic to-day are generally of the two-rope type, and with the exception of the one made by the Brown Hoisting Machinery Company, open and close in about the same manner as those which have been used for the past twenty years, and which, I believe, require no particular mention here.

The design and principle of working of the Brown bucket is novel. On account of the motion of the digging blades on most buckets, weight, as mentioned above, plays a very important part in how good a digger the bucket is, but in the bucket I refer to a new principle is brought into play.

In Fig. 4 will be seen one of the Brown buckets in open conditions. A 5-ton bucket of this make, when open, has a spread of its cutting edges of 14 feet. The blades, when open, stand almost in a vertical position, and when closing, they retain this vertical position for nearly one-half of their stroke, and their action during this time on the material is one of scraping. By the time they have moved through half

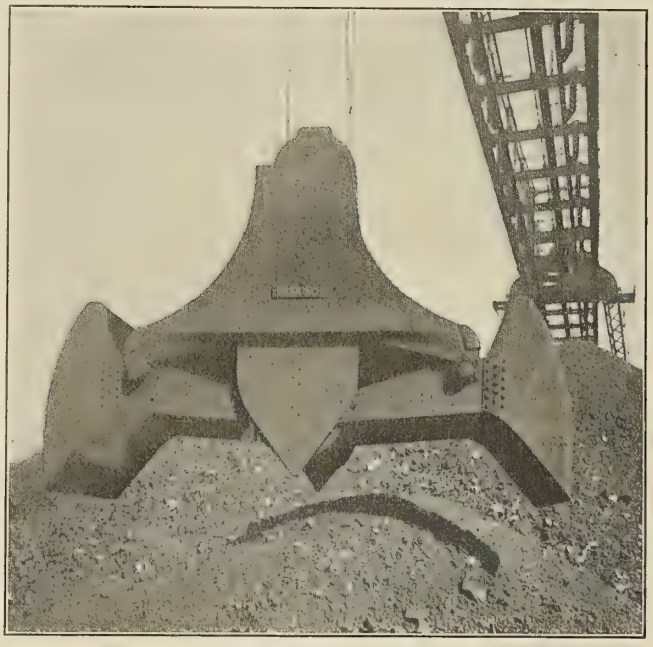


FIG. 4.—GRAB-BUCKET FOR HANDLING COAL.

of their total stroke they have gathered or scraped together a pile of material between them, and at this point the motion of the blades changes to one of rotating, so that they close under the pile of material gathered together. The bucket is so proportioned that the pile which is gathered equals approximately the capacity of the bucket. This grab, also, by its construction is admirably suited for handling lumpy material, inasmuch as the side plates forming the blades of the bucket are cut away at such an angle that the same is past the angle of friction, so that any material getting in front of the edges of these side plates will not cause the bucket to slide over them, but must, by virtue of the angle of these edges, be pushed ahead or to one side. I believe that this feature of the Brown bucket is not found in any other make.

To fill up the gap caused by cutting these edges away as above described, there will be noticed a fixed projection to the shell of the bucket, which when the bucket is closed, closes up the opening between the two spades of the bucket. These buckets will handle in iron ore about the same weight of material as the weight of the bucket.

With the adoption of the grab bucket came still another change in the general design of unloading machinery. The operating machinery on unloaders had, up to this time, always been located in a fixed machinery house, and the action of the machinery was under the control of an operator, located at some fixed point on the machine. With the grab, practically no men were needed in the boat for successful opera-

tion, and the signal men, who had been required when handling the hand-filled tubs, were unnecessary, and consequently it was found more efficient to have the operator travel with the trolley in order that he might see the bucket when in the hold of the boat. To accomplish this, the hoisting and operating mechanism on the machine was all installed on the moving trolley, and this type of trolley has (as it is generally known) become to-day to be recognized as the most efficient and rapid.

Although builders had employed electric power to some extent before the adoption of the man trolley machines, and it had been foun an improvement in many ways over the steam power, the man trolley machines could not be satisfactorily arranged to be operated by any other force than electric, and we might say that the advent of the grab bucket has marked the almost universal use of electricity in unloading machinery, and by its adoption the expense and labor of handling coal, ashes, water, etc., has been saved.

*(To be concluded.)*

## MARINE PROPULSION BY ELECTRIC MOTORS.*

BY H. A MAVOR.

At first sight it would appear that on a ship the direct connection between the power generator and the propeller renders unnecessary the use of any intermediate transmission device, and so long as reciprocating steam engines were the best attainable power generators it was possible to correlate the speeds of generator and propeller so as to gain the best efficiency of each. The steam turbine and the non-reversible internal combustion engine introduce a new set of conditions. On land the turbine holds the field for the largest powers, and because its speed of revolution is unsuited to any ordinary mechanical direct application of power for industrial purposes, its evolution has been directly associated with electrical transmission. These turbines are many of them of the same order of magnitude as the turbines used on shipboard, and therefore a comparison of economy in the two conditions is inevitable.

Before the introduction of electric transmission the marine engineer had the more complete scientific data, and consequently the marine engine held the blue ribbon of economy which now belongs to the turbo-electric generator. Among the reasons for the higher efficiency of the land turbines are: That the engineer on land is freer than is the marine engineer to adopt a suitable speed of revolution; that the land turbine runs at approximately constant speed for all loads, and can therefore be run on the governor, rendering easier the application of superheat and augmented vacuum; that on land it is possible to subdivide the power units to meet the conditions of varying load, and thus maintain at the smaller loads an efficiency not materially different from the efficiency at the full load of the system; that at sea, change of power is directly associated with change of speed, and the whole of the power units must always be in motion while the ship is in motion. The same engine has to run the ship at 10 knots and at 20 knots, although the power varies very widely between those limits. Also the high economy on land of power production, associated with electric transmission, is largely due to the possibility of exact measurement of power under all conditions of load, giving a complete knowledge of the effect of all changes in the apparatus or in the methods of working it.

The proposition here made is to provide an electric equipment intermediate between the prime mover and the propeller, extending the limits of practical economy in each by modifying the restrictious which the prime mover and propeller impose upon one another, and providing that the prime mover may operate at or near the constant speed required for the attainment of maximum efficiency and full power, and that the power expended in driving machinery not required for work is reduced to a minimum or entirely eliminated. At full power all the elements of the generating plant are in full operation, and the whole power resources can be concentrated on driving the ship. When full power is not required, the generating plant may be shut down in sections.

To accomplish these ends special motors have been designed, which give the necessary changes of speed and direction and permit of the advantageous combination or elimination of the power generators. These motors involve no new electrical principle, but simply mechanical adaptation of well-known electric designs. Alternating current alone is available for the purpose in question, and normal motors have therefore a fixed speed of rotation, which is a simple multiple of the generator speed.

Two methods of speed change are proposed, each associated with a new form of motor.

The principle of operation of the "Spinner" motor is, that an ordinary normal motor driving the propeller at a fixed speed, with the shaft and propeller directly connected, is so arranged as to be rotatable as a whole about the propeller-shaft axis. This rotation is accomplished by a second motor concentrically arranged outside the first, so that the main motor system may be rotated in either direction—again at a fixed speed, which is a simple multiple of the generator speed—and the speed of rotation of the propeller shaft and of the propeller in the water is the algebraic sum of the rotation of the main motor and the rotation imposed upon it by the auxiliary motor.

As both motors are reversible, it will be seen that in each direction there are three speeds:

1. The speed of the main motor system: the middle speed.
2. The speed of the main motor system minus the speed of the auxiliary motor system: the low speed.
3. The speed of the main motor system plus the speed of the auxiliary motor system: the full speed.

The combination may be designed for any three-speed ratios, such as 1, 2, 3; 2, 3, 4, etc. Any intermediate speeds required are attainable by adjustment of the turbine or engine governor, which can be operated economically through a range down to about 75 percent of full speed. The same method is applicable to non-reversible internal combustion engines.

The "Multiple" motor is an ordinary squirrel-cage induction motor in all respects, except that its stator is wound with two or more independent electric circuits, each associated with a separate source of supply of energy.

For example, the motor may be fed from two sources of supply at 25 and 50 periods, respectively, the motor windings being for 46 and 92 poles. At full power and speed, both windings are in operation under their most advantageous conditions; each of these windings results in a synchronous speed of 66 revolutions per minute. When the 25-period current is supplied to the 92-pole winding the speed is 33 revolutions per minute.

Either of these motors permits of one or more generators being used together in the same mechanical system without electrical connections or synchronizing devices.

The author then goes on to discuss the application of electric propulsion to certain definite types of ship, and also gives diagrams illustrating the saving in space obtained. The examples worked out are as follows:

1. In a cargo vessel of 840 shaft horsepower, the normal reciprocating engine equipment with a single screw would weigh 570 tons for engines, boiler and fuel. The electrical equipment, consisting of three oil engines, three motors and three propellers, would weigh only 270 tons, including fuel. Fur-

* Abstract of a paper read before the Institution of Civil Engineers, December, 1909.

ther, with coal at $4.75 (20s.) per ton, and oil at $9.50 (40s.) per ton, the saving in fuel-cost on a total of $82 (£17) would be $25 (£5 6s.) per day at full power.

2. In a similar cargo vessel gas engines might be used. Taking an equipment of 770 shaft horsepower, and using three gas engines and one multiple motor, the respective weights of the normal and proposed equipments would be 446 tons and 229 tons. The consumption of fuel shows an equally favorable comparison.

3. A third cargo vessel, but of 1,030 shaft horsepower, is worked out for the purpose of illustrating the application of steam turbines to the multiple motor. One plant drives the ship under normal conditions: extra power is supplied by a small turbo-generator, and is used to keep up the ship's speed in heavy or contrary weather.

4. On a passenger vessel of, say, 16,200 shaft horsepower, the electrical equipment permits of a subdivision of the plant, so that at speeds lower than the maximum, only part may be run, and that at full power. This advantage is gained without loss in full-power economy, and without additional complication.

## The Possibility of Replacing Magnetic by Rotary Compasses.

BY OUR BERLIN CORRESPONDENT.

The tendency shown by a top, free to move in a horizontal plane, to orientate its axis in a north-south direction, and which would allow it to be used as a "rotary compass," was discovered as far back as 1852 by Léon Foucault. Eneavors have since been made to design an outfit, by means of which

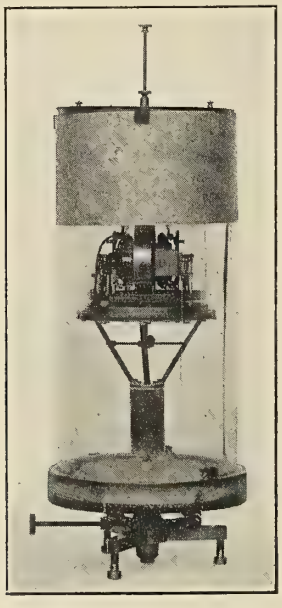


FIG. 1.

this novel compass might be used for practical purposes, without, however, obtaining any affirmative results.

In view of the deformations undergone by the field of terrestrial magnetism under the influence of the armor plates of vessels, the navies of various countries have recently taken up again this interesting problem, and O. Martienssen has been intrusted by Siemens & Halske to consider the construction of a rotary compass on the basis of experiments commenced as far back as ten years ago by Werner von Siemens. The following apparatus was accordingly constructed:

The rose of the compass *B* (Fig. 2) is floating in the vessel *A*, filled with petroleum, while resting with a pressure of several grams on the stone-bearing *C*. This rose is itself an air-tight vessel with metal bottom and glass globe, in which the rotating body *E* rests with its axis *M* on the friction wheels *G*. Two electro-motors *F* allow this axis to be imparted a very rapid rotation, the current being supplied from the lower bearing and the bottom of the vessel, on one hand,

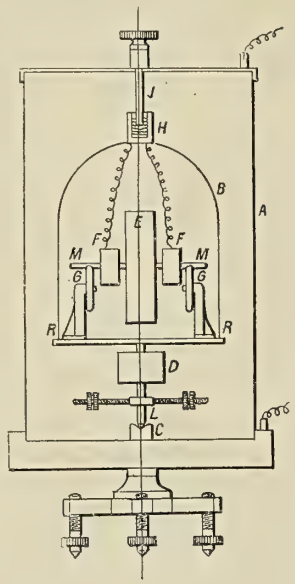



FIG 2.

and the mercury cup H on the other. The rose of the compass carries a lead weight *D* placed underneath and intended for displacing the center of gravity as far down as possible. The position of the axis of rotation is read on one hand from the graduated circle *R* at the bottom of the rose, and on the other from a mark on the outside vessel *A*. This apparatus thus mainly consists of a top or gyroscope, the axis of which is kept horizontal by the force of gravity, and which, along with its support, is free to rotate round a practically vertical axis.

After studying the theory of the apparatus, Mr. Martienssen undertook a first set of experiments, in the course of which the directive force of the compass rose was, however, found to be very small. The stability of the rose was then increased (by arranging bearings also at its upper end), thus greatly augmenting this directive force and even rendering it in some cases far superior to that of a magnetic compass. On board a vessel there will, it is true, arise some complications from the motion of the ship itself, and in view of these disturbances correct reading can be expected only under special conditions, unless a cardan suspension with fixed axis be adopted. Any variation in the speed will, however, even then result in a deflection from the vertical, which, it is true, remains quite inappreciable as long as the acceleration of the vessel is kept constant.

In order to reduce, as far as possible, the disturbances above mentioned, the duration of an oscillation of the top or gyroscope should be increased to a high extent, which, however, would diminish its suitability as a rudder compass.

### Motor Boat Show

The annual meeting of the Motor Boat Show, given under the auspices of the National Association of Engine and Boat Manufacturers of America, is to be held in Madison Square Garden, New York City, Feb. 19 to 26, inclusive.

## THE MARINE STEAM ENGINE INDICATOR—VII.*

BY LIEUT. CHARLES S. ROOT, U. S. R. C. S.

### REDUCING MOTIONS.

The maximum stroke or travel of the cord actuating an indicator paper drum averages about 4½ inches, and it is therefore impossible to connect the cord directly to an engine cross-head, except in the case of very small engines or pumps, when the stroke is equal to or less than the length above mentioned. This condition makes it necessary to fit some form of mechanism for reducing the travel of the cross-head to that of the indicator drum. Such appliances are generally known as reducing motions. As the horizontal components of the indicator diagram affect its area and form, it is necessary, if correct results are to be obtained, that the horizontal motion of the card or paper drum be an exact copy of the piston movement.

Probably the most simple reducing motion—which is mathematically correct—is the reducing wheel. The basic principle of this mechanism is as follows: Two wheels of different diameters are keyed to the same shaft; the larger wheel has a circumference equal to the engine stroke, and the periphery of the smaller equals the desired card length. A cord is wrapped

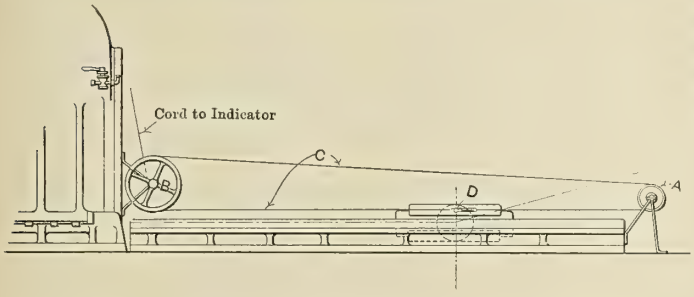



FIG. 50.

about the large wheel and made fast to the engine cross-head, and a cord attached in a similar manner to the small wheel is connected to the indicator. The cord connection between the large wheel and the engine cross-head must be so attached that it will be parallel to the engine center line at all times, and the cord from the small wheel must lead off at 90 degrees with the shaft axis. If these last conditions obtain, the velocity ratio between the engine cross-head and the indicator drum will be constant, and this is the essential feature in all reducing motions. A mechanism constructed in this manner would, in practice, be so heavy—if made to fit a large engine—that the inertia would cause large distortion. The wheels are therefore reduced in diameter, so that the shaft makes several turns during each stroke of the engine, but the proportion between the *circumferences* of the wheels is maintained as before. In most modern forms of this device, take-up or recoil springs are fitted for turning the shafting against the pull of the cross-head cord, and gears are frequently used to get the proper velocity ratios.

An easily made form of reducing wheel, suitable for slow speed, horizontal or inclined engines, is shown in Fig. 50. The wheel *A* is an idler, and *B* is the reducing wheel. The belt or cord *C* is attached to the cross-head at *D* by means of an off-set stanchion bolted fast to the cross-head. A simple lanyard passed through rings in one end of the cord and on the stanchion is fitted at *D* for taking up the slack. A round turn is sometimes taken about the reducing wheel. Recoil springs are unnecessary.

* Copyright, 1910, by Charles S. Root.

A modern form of reducing wheel and one that requires but a single cord leading to the engine cross-head is shown in Fig. 51. This mechanism represents that class which is not fitted with gears, and the particular one illustrated is made by the Trill Indicator Company. When connected up as shown in the figure, the reduction is accomplished in two stages. The cord from the cross-head is first passed through the guide pulley

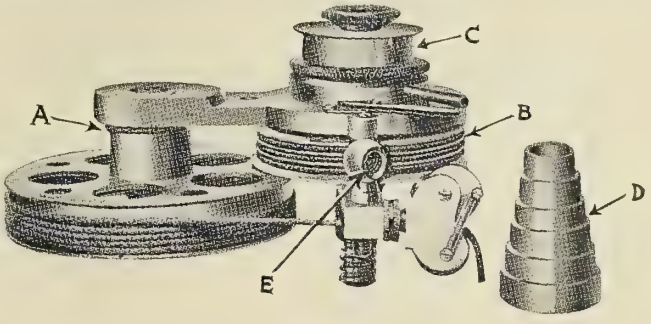



FIG. 51.

and then around the large wheel at the left and its motion reduced in the ratio of 3½ to 1 before it is transmitted to the wheel *B* by means of the cord, one end of which is shown attached to the boss of the large wheel at *A*. The wheel *B* is about 2½ inches in diameter and carries a spiral recoil spring whose tension is adjustable. The upper or small wheel *C* is attached to the same shaft and revolve with *B*. This wheel consists of a nest of aluminum bushings (shown in detail at *D*) clamped to the innermost wheel by the cover plate and

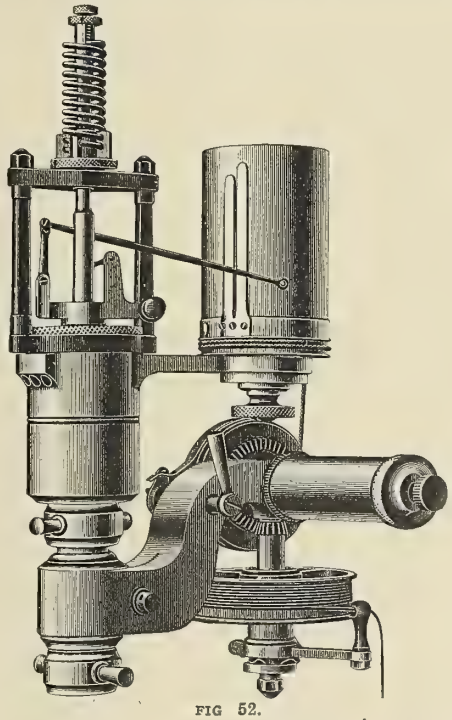


FIG 52.

milled nut at the top. The cord leading to the indicator drum is passed around and made fast to *C*. The wheel connected up as shown is good for all strokes between 20 and 60 inches. For strokes under 20 inches, the guide pulley is inserted in *E*, and the large wheel at the left is thrown out of use, the cross-head cord leading directly to the wheel *B*. The wheel rigged in this manner is good for strokes between 6 and 20 inches, all intermediate changes being made by changing the aluminum bushings shown at *D*. The two large wheels are made of aluminum to reduce inertia effects. An up-and-down motion is imparted to the cord guide by a square thread on the lower

end of the shaft which carries *B*. One revolution of the large wheel moves the guide an amount equal to the diameter of the cord, so that the end winds on the wheel in a spiral and the turns cannot "ride." This wheel can be bolted to the engine housing, or be so made that it will fasten directly to the indicator frame in place of the guide pulley arm.

The Crosby reducing wheel is shown in Fig. 52, and its operation is at once understood by an inspection of the cut. The take-up spring is helical and is inclosed in the cylindrical case surrounding the horizontal shaft. The rig may be attached directly to the engine cylinder cock, and the indicator in turn secured to the frame of the wheel, as shown in the figure, and in this way no strain is brought on the frame of the indicator. If desirable, the wheel may, of course, be attached to a support located in any position on the engine housing, where a good lead may be obtained for the cross-head cord. Reducing wheels must be used with caution, especially when the rotative speed is high, and the operator should see that the recoil springs are so adjusted that the effects of inertia are reduced to the lowest terms.

(*To be continued.*)

## TURBINE PROPULSION—RECENT DEVELOPMENTS.

BY R. M. NEILSON.

The steam turbine, as is well known, is very old, and even the Parsons and De Laval machines date from about 1883; but the era of steam turbine ship propulsion may be said to commence only in January, 1894, when the success of the Parsons steam turbine on land was sufficiently pronounced to lead to the formation in Great Britain of a small syndicate—the Marine Steam Turbine Company—for the purpose of applying this type of motor to the propulsion of ships. The *Turbinia* was built, and the first preliminary trial of this vessel took place on November 14, 1894. It is unnecessary here to mention the first failures and the subsequent success of this vessel, or to trace the developments in turbine ship propulsion from the *Turbinia* to the steam turbine installations of the *Lusitania* and *Mauretania* and recent large battleships and cruisers.* It is intended rather in this article to discuss certain recent developments and proposals relating to steam turbine propulsion.

### THE RECIPRO-TURBINE COMBINATION.

It is an old idea, but only within recent years put into practice, to combine a reciprocating high-pressure engine with a low-pressure turbine. A good reciprocating engine can efficiently utilize the available heat energy in steam down to about half an atmosphere—more or less according to the dimensions of the low-pressure cylinder. It can benefit by a vacuum much below half an atmosphere, but its efficiency as regards the work obtained from the available heat energy of the steam below this pressure cannot be said to be high. The efficiency of a steam turbine, on the other hand, may be said to be approximately constant at all stages of the pressure drop down to, say, 1 pound per square inch absolute. The turbine is not, by any means, an ideal motor for the propulsion of ships, because, with the possible exception of high-power, high-speed vessels, its desirable speed of rotation, to secure low weight and low cost and high efficiency, for the turbine is not conducive to high efficiency in the propeller. It is, therefore, not surprising that, at an early date in the history of steam turbine ship propulsion, proposals were made to employ reciprocating engines to utilize the first portion of the available energy in the steam, and turbines to complete the expansion.

A combination of reciprocating engines and turbines was installed in the British destroyer *Velox* about eight years ago, but in this case the reciprocating engines are comparatively small and are employed only at cruising speeds when they exhaust into the high-pressure turbines, whence the steam passes to the low-pressure turbines. At high speeds the reciprocating engines are disconnected from the propeller shafts and the steam supplied direct to the high-pressure turbines.

In a torpedo boat built about 1904 by Messrs. Yarrow & Co., Ltd., both reciprocating engines and turbines are employed for propulsion, but the reciprocating engines—which drive the center shaft—are quite independent of the turbines which drive the wing shafts, both types of engine receiving steam direct from the boilers and discharging it direct to the condensers. In the case of the turbines the steam passes in series through a high-pressure and a low-pressure turbine arranged on separate shafts. In the torpedo boat *Goyaz*, built by the same firm for the Brazilian Government, a combination arrangement was also provided, but in this case also the reciprocating engines and the turbines work independently: the former alone are used for reversing and for cruising.

None of these torpedo craft, however, can serve as an example of what can be achieved by the recipro-turbine combination as regards the efficient propulsion of a ship: the *Otaki*, completed little more than a year ago, was the first vessel having reciprocating engines and turbines intended to be run in series at full power.

The *Otaki* has already been described.* Suffice it to say here, that this vessel carries two sets of triple-expansion reciprocating engines which drive wing shafts and exhaust into a single low-pressure turbine, which drives a central propeller shaft. Comparisons between the *Otaki* and a sister ship, the *Orari*, given in a paper read in August last by Engineer-Commander Wisnom (of the builders' firm) before the joint meeting of the Institution of Engineers and Shipbuilders in Scotland, and the North-East Coast Institution of Engineers and Shipbuilders, showed the *Otaki* to be superior to her sister in point of economy, to the extent of 17 percent on trial at 14 knots, and about 8 percent at the speed employed in service. Further experience with the *Otaki* has demonstrated that her advantage over the *Orari* in service is somewhat greater than 8 percent. Moreover, it was stated by Commander Wisnom, in replying to the discussion on his paper, that the arrangement in the *Otaki* could probably be improved in future ships, so that still better results may be obtained from the combination system.

In the interesting discussion which followed the reading of Commander Wisnom's paper no doubt was expressed as to the greater economy of the combination system over the usual wholly reciprocating drive for the propulsion of vessels of moderate speed; but some doubt was expressed as to whether the gain in economy was worth the extra complication.

It would appear to be necessary to provide more room for the engines and shafting in a vessel having the recipro-turbine combination of machinery than in a similar vessel propelled by the ordinary marine type of engine. In the case of the *Otaki* there was room for the turbine between the two sets of reciprocating engines, so that the dimensions of the engine room were the same as in the *Orari*, but the length of the *Otaki* was made 4 feet 6 inches greater than that of her sister ship, to make up for the loss in cargo capacity, due to three shaft tunnels instead of two. In other cases, however, the length of the engine room in a combination boat might have to be considerably increased above what would be necessary with a simple reciprocating drive, because the provision of a low-pressure turbine allows of but little shortening of the fore-and-aft length of the reciprocating engines, while a large

* For historical sketch, see "The Steam Turbine," by R. M. Neilson, fourth edition, Longmans & Co.

* International Marine Engineering, February, 1909, and October, 1909.

condenser or condensers are required, which will usually have to be placed aft of the engines. Moreover, cases may occur where there will not be room for the turbine between the two sets of reciprocating engines.

In the case of the White Star boats *Laurentic* and *Megantic,* of which the former has the recipro-turbine combination and the latter the ordinary drive, the *Megantic* is provided with quadruple-expansion tngines, while, owing to the employment of a low-pressure turbine in the *Laurentic,* a triple-expansion arrangement of reciprocating engines has been considered sufficient for this vessel. The low-pressure cylinder in the *Laurentic* has, however, been divided to produce smoother running, so that each vessel has two 4-cylinder sets of engines. The diameters of the cylinders in the *Laurentic* are 30, 46, 53 and 53 inches (the stroke being 54 inches), while the *Megantic's* cylinders are 29, 41½, 61 and 87 inches (with a stroke of 60 inches), so that the difference in the fore-and-aft length of the engines in the two vessels is probably only about three or four feet, and whereas the condensers of the *Megantic* are located in the engine framings, those of the *Laurentic* are independent structures placed aft of the engines.

It may be remarked here that, not only must the condensers and air pumps in a combination boat be larger than are required in a vessel propelled by piston engines only, but, in fixing on the dimensions and design of condenser and air pump, it must not be assumed without investigation that the requirements will be the same as in a vessel propelled by turbines only, because the steam consumption will probably be greater in the latter than in a combination vessel and the air leakage may be either more or less.

As regards space required by the boilers, the greater economy of the recipro-turbine combination will allow of the provision of less steam-generating capacity, so that on the whole it would appear that the total propelling machinery in a combination boat will require little more room than is necessary in a boat propelled by simple reciprocating engines, the precise ratio of space required varying according to the particular conditions in the vessels being considered.

As regards relative weights, the total weight of machinery in the *Otaki* was about 30 tons, or 3.25 percent, more than in the *Orari,* but the boiler installation was the same in the two vessels, whereas less boiler power would have sufficed for the *Otaki* to allow of the same maximum speed being obtained. Had the boiler-room weights of the *Otaki* been reduced, say 10 percent, the total weight of machinery in this vessel would probably have worked out considerably less than that in the *Orari.*

The greater economy obtainable by the combination system will allow of less bunker capacity being provided, and there will be a difference in bunker weights, especially at the beginning of a voyage. This advantage as regards bunkers will be more pronounced in the case of vessels going long trips without recoaling than in the case of ships doing only short runs.

As regards the pressure at which the steam exhausts from the reciprocating engines and is supplied to the turbine, in the *Laurentic* this pressure is said to be about 18 pounds per square inch absolute: in the *Otaki* at full speed the pressure is about 10 pounds absolute, but at a speed of about 11 knots—at which speed the vessel made a round trip from Liverpool to New Zealand and back—the pressure at admission to the turbine is only about 4.5 pounds absolute.

The best pressure at which to transfer the steam from the piston engines to the turbine must be considered for each case, it is obvious that no hard-and-fast rule can be laid down, but it may be said that at the speed at which the vessel most often runs, the transfer pressure should never be less than 7 pounds absolute.

Increase in the transfer pressure reduces the size and weight of the reciprocating engines, while the size and weight of the turbine is not increased by an equal amount. The employment of relatively small reciprocating engines with a high mean effective pressure referred to the low-pressure cylinder is conducive to obtaining high mechanical efficiency, while the effective efficiency of the turbine, or ratio of brake work to the available energy in the steam, is not improved by lowering the admission pressure when this pressure is in the neighborhood of, or below, the atmosphere. The volume of the low-pressure cylinders in the *Otaki* is about 57 percent of that of the low-pressure cylinders of the *Orari,* while the combined volume of the two low-pressure cylinders in each of the sets of piston engines in the *Laurentic* is about 67 percent of the volume of the single low-pressure cylinder in each set of engines in the *Megantic.* The volume in each case is taken as the internal area of section of the cylinders multiplied by the stroke.

Too high a transfer pressure gives the turbine-driven propeller an undue amount of work to do; and it must be remembered that this propeller is the least efficient of the three.

TABLE I.—RECIPRO-TURBINE YACHT EMERALD.*

| Transfer Pressure, Lbs. per Sq. In. Abs. | Vacuum, In. of Merc. | Percent of Total Power Developed by | |
|---|---|---|---|
| | | Recipro-Engines. | Turbine. |
| 11.6 | 27.4 | 70 | 30 |
| 10.6 | 27.4 | 72 | 28 |
| 7.0 | 27.7 | 79 | 21 |

* Prepared from Mr. R. J. Walker's comments on Commander Wisnom's paper before mentioned.

Table I. refers to Sir Christopher Furness' yacht *Emerald,* which was first propelled by steam turbines only, but a little more than a year ago was converted to the combination system. The table gives the percentages of the total power developed by the reciprocating engines and the turbine, respectively, with different transfer pressures. In obtaining these percentages the indicated horsepower of the reciprocating engines, and the shaft horsepower of the turbine, were taken.

TABLE II.—WORK OBTAINABLE FROM THE EXPANSION OF ONE POUND OF SATURATED STEAM.

| Initial Pressure Pounds per Sq. In. Abs. | Final Pressure Pounds per Sq. In. Abs. | Total Work Obtainable, Foot-Pounds. | Transfer Pressure Pounds per Sq. In. Abs. | Work Obtainable Before Transfer, Foot-Pounds. | Work Obtainable After Transfer, Foot-Pounds. | Percent of Work Obtainable. | |
|---|---|---|---|---|---|---|---|
| | | | | | | Before Transfer. | After Transfer. |
| 250 | 1.0 | 270,000 | 20 | 146,000 | 125,000 | 54 | 46 |
| | | | 15 | 160,000 | 110,000 | 59 | 41 |
| | | | 10 | 176,000 | 94,000 | 65 | 35 |
| | | | 7 | 192,000 | 78,000 | 71 | 29 |
| 200 | 1.0 | 260,000 | 20 | 132,000 | 128,000 | 51 | 49 |
| | | | 15 | 146,000 | 114,000 | 56 | 44 |
| | | | 10 | 163,000 | 97,000 | 63 | 37 |
| | | | 7 | 181,000 | 79,000 | 70 | 30 |
| 170 | 1.0 | 250,000 | 20 | 124,000 | 126,000 | 50 | 50 |
| | | | 15 | 136,000 | 114,000 | 54 | 46 |
| | | | 10 | 154,000 | 96,000 | 62 | 38 |
| | | | 7 | 172,000 | 78,000 | 69 | 31 |
| 140 | 1.0 | 243,000 | 20 | 112,000 | 131,000 | 46 | 54 |
| | | | 15 | 126,000 | 117,000 | 52 | 48 |
| | | | 10 | 144,000 | 99,000 | 59 | 41 |
| | | | 7 | 161,000 | 82,000 | 66 | 34 |
| 250 | 1.5 | 255,000 | 20 | 146,000 | 109,000 | 57 | 43 |
| | | | 15 | 160,000 | 95,000 | 63 | 37 |
| | | | 10 | 176,000 | 79,000 | 69 | 31 |
| | | | 7 | 192,000 | 63,000 | 75 | 25 |
| 200 | 1.5 | 244,000 | 20 | 132,000 | 112,000 | 54 | 46 |
| | | | 15 | 146,000 | 98,000 | 60 | 40 |
| | | | 10 | 163,000 | 81,000 | 67 | 33 |
| | | | 7 | 181,000 | 63,000 | 74 | 26 |
| 170 | 1.5 | 236,000 | 20 | 124,000 | 112,000 | 53 | 47 |
| | | | 15 | 136,000 | 100,000 | 58 | 42 |
| | | | 10 | 154,000 | 82,000 | 65 | 35 |
| | | | 7 | 172,000 | 64,000 | 73 | 27 |
| 140 | 1.5 | 227,000 | 20 | 112,000 | 115,000 | 49 | 51 |
| | | | 15 | 126,000 | 101,000 | 55 | 45 |
| | | | 10 | 144,000 | 83,000 | 63 | 37 |
| | | | 7 | 161,000 | 66,000 | 71 | 39 |

Table II. gives the percentages of the work obtainable from the expansion of steam above and below certain transfer pressures. The values are given in round numbers; great exactitude is unnecessary owing to the doubt as to the exact value of the mechanical equivalent of heat.

As regards the maintaining of a high vacuum, which materially affects the shaft power developed by the turbine, there is an advantage in having the transfer pressure above atmosphere, as in this case there is less chance of leakage of air by the glands into the low-pressure cylinders of the piston engines.

### SUPERHEATED STEAM.

The employment in steamships of superheated steam has already been discussed in International Marine Engineering.* The writer will, therefore, in this article make no remarks on the construction or arrangement of superheaters or superheating tubes or the difficulties encountered in the superheating of steam or the use of the latter with reciprocating marine engines. A few remarks will, however, not be out of place on the special difficulties in connection with the employment of superheated steam in steam turbines for ship propulsion.

The troubles encountered in the employment of turbines of the Parsons type, both on land and at sea, have not, on the whole, been great, nor have serious accidents been numerous; but a large proportion of the troubles and accidents that have occurred are due to the unequal expansion of different portions of the turbine.

Saturated steam at a pressure of, say, 200 pounds per square inch above atmosphere, has a temperature of about 388 degrees F. The heating of parts of the turbine to nearly this temperature while other parts remain cold may cause quite a considerable relative displacement or distortion; but if the steam is superheated, say, 100 degrees, the conditions are very much worse.

In all turbines of the Parsons type it is desirable to keep the radial clearances at the blades small to reduce the leakage of steam from stage to stage. Any bending or angular distortion of the rotor or casing, therefore, endangers the rubbing of the ends of some of the rotating blades on the interior of the casing, or the rubbing of part of the rotor-drum on the ends of the fixed blades. To reduce the risk of blade-stripping, due to such a rubbing action, the blades are sometimes, according to the Willins-Sankey system (employed in America by the Allis-Chalmers Company), very securely connected together in sections before being attached to the rotor and stator, respectively, and the tips of the blades of each section connected together by a strip of metal of channel section, so that no stripping would appear to be possible without the employment of great force.

Another device for reducing the risk of stripping consists in thinning the blades at their tips, so that when rubbing occurs the tips of the blades will get worn down. As rubbing usually occurs only at one place in the length of the turbine, such rubbing down of the blades and the increased clearance produced will not very greatly affect the efficiency of the turbine as a whole.

Experience has shown, however, that neither of these devices absolutely prevents stripping; and both devices are objectionable, in the author's opinion, as tending to slightly reduce the efficiency of the turbine by upsetting the regular flow of the steam. Moreover, when axial dummies are employed at the glands, or for balancing purposes, no large relative axial movement between rotor and stator is allowable.

The danger of damage through unequal expansion is, therefore, greatly increased when superheated steam is used, although in electrical power stations on land it is the usual practice now to employ superheated steam for all types of turbines, and the machines with care have been found to work quite satisfactorily, the accidents, considering the number of turbines now in use, being comparatively infrequent. It must be remembered, however, that in electrical power stations there is usually at least one unit in reserve, which is not the case as regards the use of turbines in the propulsion of ships.

A recent patent of the Hon. Charles A. Parsons relates to the employment of a heat buffer intended to be placed between the steam turbine and the boiler or superheater, so as to shield the turbine from abrupt changes of temperature. The buffer is a heat reservoir, which reduces or increases the temperature of the steam passing to the turbine as required, so as to prevent any sudden admission of very hot steam to the turbine, and also to reduce any violent fluctuations in the temperature of the fluid at any time.

During the last year or two, proposals to employ superheated steam on turbine steamships have been looked at with somewhat less disfavor than formerly; and the employment of steam superheated to a moderate amount, say 50 to 75 degrees F., appears probable in the near future. With superheated steam it will be unnecessary to generate steam in the boilers at a very high pressure, which, in the case of vessels employing firetube boilers (and this class includes practically all turbine-propelled steamships except war vessels), is a matter of considerable importance.

### SINGLE-SHAFT VS. DIVIDED-SHAFT ARRANGEMENTS.

The *Turbinia* was successfully propelled by turbines only when three shafts were provided and a turbine placed on each shaft, the three turbines being arranged in series as regards the flow of the steam. In all later vessels propelled by Parsons turbines, three or more turbines have been provided on independent shafts. Several arrangements are shown diagrammatically in Figs. 1-8, in which the following abreviations are used:

TUR. = Complete expansion turbine.
H. P. T. = High-pressure turbine.
I. P. T. = Intermediate-pressure turbine.
L. P. T. = Low-pressure turbine.
C. T. = Cruising turbine.
H. C. T. = High-pressure cruising turbine.
L. C. T. = Low-pressure cruising turbine.
R. T. = Reversing or astern turbine.
H. R. T. = High-pressure reversing turbine.
L. R. T. = Low-pressure reversing turbine.
CON. = Condenser.

A vessel could not be efficiently propelled by a single propeller driven by a steam turbine of the Parsons type; more than one propeller on a single shaft is objectionable; and, therefore, a plurality of shafts must be employed. This being so, it is undesirable to divide the expansion of the high-pressure steam over more units than necessary, as the smaller the units the poorer the efficiency. The arrangement of one high-pressure turbine driving a central shaft and two low-pressure turbines, each driving a wing shaft (as shown in Fig. 1), therefore appears very suitable; and this arrangement has been very generally adopted. Bulkhead arrangements, however, or the desirability of distributing the thrust over more than three propellers, has frequently called for the employment of four shafts, and two high-pressure turbines have then been employed (as shown in Figs. 4, 6 and 8).

Recently other types of turbines than the Parsons have been employed for propelling ships; for example, the Curtis, the A. E. G. (Allgemeine-Elektricitäts-Gesellschaft), the Zoelly and the Schichau (Melms-Phenninger) and the manufacturers of these turbines have preferred to adopt what has been called the "single-shaft" arrangement. This does not mean that only a single propeller shaft is employed to propel the vessel,

* International Marine Engineering, July, 1909; August, 1909, and October, 1909.

but that the expansion of the steam is completed in a turbine or a pair of turbines on one shaft, each shaft being thus independent of the others; either two or three shafts are employed. This single-shaft arrangement is more suitable for use with impulse turbines than with turbines of the Parsons type, but to explain this matter satisfactorily would necessitate entering into a discussion of the theory of action of steam turbines, which would be beyond the scope of the present article.

Much discussion has taken place, especially in Germany, as to the relative advantages and disadvantages of the single-shaft and divided-shaft arrangements.

In many cases a single-shaft arrangement has an advantage where the propelling machinery is split into two or more compartments by water-tight bulkheads. In Fig 7 is shown, diagrammatically, the arrangement of the A. E. G. turbines in a battleship. The machinery is divided by two longitudinal bulkheads into three compartments, each of which is independent of the other two. Fig. 5 shows, diagrammatically, an arrangement of Curtis turbines in which there are two engine rooms separated by a cross-bulkhead. The turbines in the two engine rooms are, as before, independent of each other, but in this case the steam for the aft turbine has to pass

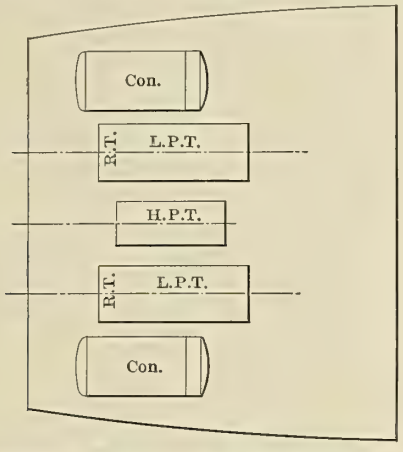



FIG. 1.—ARRANGEMENT OF MACHINERY IN THE CROSS CHANNEL STEAMER LONDONDERRY, PARSONS TURBINES.

through the forward engine room. Figs. 4, 6 and 8 show, diagrammatically, bulkhead arrangements employed with Parsons turbines. It will be seen that, while in some cases the single-shaft arrangement lends itself better to the division of the engine rooms, in other cases the one system appears to have no advantage over the other in this respect.

In vessels driven by Parsons turbines it has always been considered desirable to provide at least three shafts. In vessels, however, propelled by impulse turbines, two shafts have often been considered sufficient, the turbines rotating at a lower speed and allowing of the employment of propellers of larger diameter, the employment of two shafts instead of three generally involves less waste of space as regards shaft tunnels, and the propellers are less liable to interfere with each other.

There appears to be little difference in total weight of machinery between the two systems, although the best dimensions and speeds of rotation for any type of marine turbine have yet to be settled for all classes of vessel.

When three shafts are employed with the single-shaft arrangement, the wing turbines alone can be employed, or the center turbine alone employed, for propelling the vessel; and this, in the case of a warship, gives an opportuninty for overhauling the turbines while the vessel is cruising.

With the single-shaft arrangement both or all three shafts, as the case may be, are arranged to reverse. With the divided-shaft arrangement, usually two shafts only are arranged to reverse, and sometimes only one shaft. In British battleships fitted with turbines, however, all the shafts are arranged to reverse, Fig. 6 showing the arrangement diagrammatically. The high-pressure reversing turbines in these ships must be of material assistance in going astern, but constitute an additional drag when the vessel is going ahead.

The attachment of the blades to the rotor in impulse turbines is usually of a much stronger nature than in the case of Parsons turbines; on the other hand, the large size and weight of the impulse turbines must be an objection in some

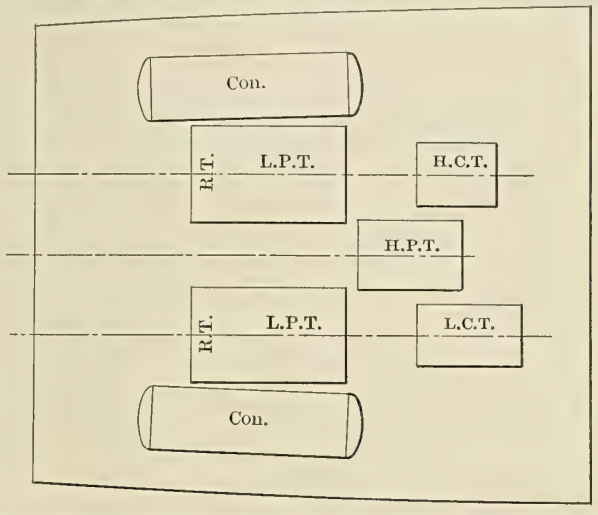



FIG. 2.—ARRANGEMENT OF MACHINERY IN A DESTROYER, PARSONS TURBINES.

cases as regards putting these engines aboard ship or removing them from the vessel.

### CRUISING TURBINES.

The first British warship to be driven by steam turbines was the *Viper*, and during the short life of this vessel it was remarked that the coal consumption at cruising speeds was very high. To meet this difficulty the destroyer *Velox*, built shortly afterwards, was provided, as already mentioned in this article, with two small sets of triple-expansion engines, which were used only at cruising speeds, the object—which was attained—being to obtain a greater economy at cruising speeds. Immediately after the *Velox* was completed, the Parsons Marine Steam Turbine Company introduced cruising turbines, and these have been fitted on a large number of

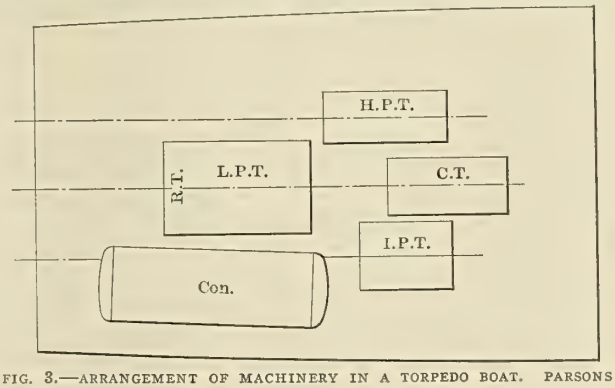



FIG. 3.—ARRANGEMENT OF MACHINERY IN A TORPEDO BOAT. PARSONS TURBINES.

British warships—battleships, cruisers and torpedo craft. The usual practice has been to provide two cruising turbines, called, respectively, the high-pressure cruising turbine and the low-pressure cruising turbine, these turbines being placed at the forward end of the engine room and on separate shafts. (See Figs. 2, 4 and 6.) When the vessel is cruising and the engines require to develop only a small fraction of their full power, the steam is passed in series through the several turbines of the vessel in the following order: First, through the

high-pressure cruising turbne; then through the low-pressure cruising turbine; then through the high-pressure main turbine or turbines, and then through the low-pressure main turbines. When, however, the vessel is running at full, or nearly full, speed, and during reversing or maneuvering, the cruising turbines are put out of action and steam supplied direct to the main high-pressure turbine or turbines. Sometimes only one cruising turbine is installed, as shown in Fig. 3.

It has not been the practice to disconnect the shafts of the cruising turbines when these latter are not required, but to

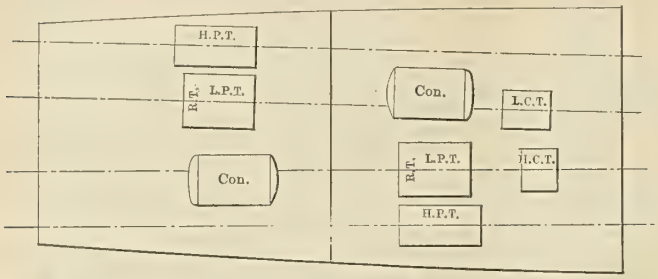



FIG. 4.—ARRANGEMENT OF MACHINERY IN U. S. SCOUT-CRUISER CHESTER, PARSONS TURBINES.

allow the rotors to rotate idly, and, in order to diminish the drag, to connect the turbines to the condenser so that the rotors rotate in the condenser vacuum.

These cruising turbines have fulfilled the purpose for which they were originated, but their use involves several objections.

In the first place their weight is considerable, and they are usually employed in warships in which weight is of great importance. The two cruising turbines of the *Dreadnought* are said to weigh together between 80 and 90 tons, which is a serious addition to the weight of machinery, when it is considered that these turbines do not in any way assist the vessel at full speed.

In the second place, the drag of the cruising turbines, when rotating idly, although small, is appreciable.

In the third place, the cruising turbines increase the chance of air leakage into the condenser and involve two further elements, which require to be looked after and are liable to injury or breakdown; and although the cruising turbines can be very quickly cut out of action whenever required, it must be remembered that any accident to their rotors necessitating the stopping of these also necessitates the stopping of the turbines which drive the same propeller shaft until the damaged turbine can be uncoupled from the other.

In the fourth place, when a longitudinal bulkhead separates the two cruising turbines one from the other, as shown in Fig. 6, and when, therefore, each is under independent control, a certain amount of inconvenience must arise through each being dependent on the other, as either cruising turbine cannot be put into, or out of, action, without affecting the other, and also affecting both high-pressure turbines (if two are employed),

The last objection could be got over by making each cruising turbine independent of the other, although in this case nearly half the advantage of their employment would be lost.

The British Admiralty have abandoned the use of cruising turbines in recently designed battleships and cruisers, although they are retained for some or all of the new destroyers. The cruising power of a destroyer is a smaller fraction of the full power than in a battleship, so that the advantage to be obtained by the use of cruising turbines would appear to be greater in the former than in the latter. Moreover, the turbines of a destroyer weigh considerably less than those in a battleship in proportion to the total engine power of the vessel, partly by reason of the greater speed of rotation, which can be adopted in the case of the destroyer, so that the gain in weight by omitting the cruising turbines is proportionately less in the destroyer than in the battleship.

To partly compensate for the omission of the cruising turbines in the new British battleships and cruisers, the main turbines are designed, at the expense of slightly extra weight, to better suit the conditions existing during cruising, and for higher speeds a by-pass arrangement is brought into use on the principle of that now well know in connection with Parsons turbines employed on land. This by-pass device does not appear to be so suitable for use with marine turbines as for turbines driving electric generators, because, in the latter

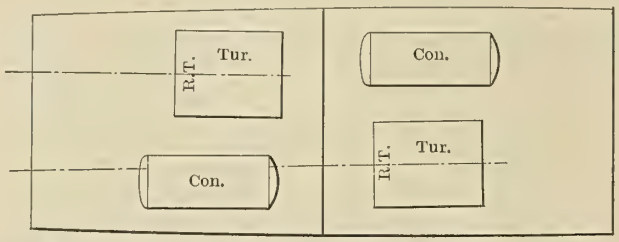



FIG. 5.—ARRANGEMENT OF MACHINERY IN U. S. SCOUT-CRUISER SALEM, CURTIS TURBINES. SAME IN TORPEDO CRAFT.

case, constant speed is required at all powers, whereas in a ship-propulsion turbine the speed of rotation is less at low than at high powers. Now, the blade speed in a turbine depends on the speed of rotation of the rotor, and the desirable steam speed depends on the blade speed. The adoption of cruising turbines, by greatly increasing the number of stages, affects a very substantial decrease in the steam speed. A by-pass arrangement also affects the steam speeds, but in a somewhat unscientific manner and not to the same extent. The aggregate disadvantages of cruising turbines are, however, so considerable that the substitution for them of a by-pass device in the case of battleships and cruisers is no doubt justified.

Cruising turbines have not, as far as the writer is aware, been employed with any except Parsons turbines.

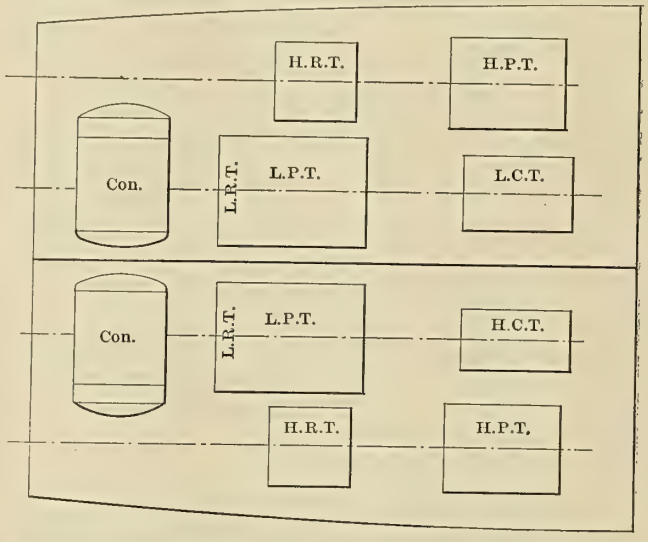



FIG. 6.—ARRANGEMENT OF MACHINERY IN A BATTLESHIP, PARSONS TURBINE.

## TURBO-ELECTRIC PROPULSION.

Much dinscussion has recently taken place in Great Britain on the question of employing steam turbines to propel vessels, not by a direct drive, but by electric transmission of power.

As is well known, the great difficulty in applying steam turbines to propel ships has resided in the fact that a high speed of rotation is desirable for the turbine, and a moderate or low speed of rotation for the propeller. In practice a compro-

mise has been struck, so that a reasonable propeller efficiency has been obtained combined with a fair efficiency in the turbine; but, nevertheless, the propeller efficiency has not been as high as would be expected had a lower rotative speed, combined with a different design of propeller been adopted, and the efficiency of the turbine has not been as great, nor has its weight and size been as low as could have been obtained had the turbine been allowed to rotate at a higher speed.

To obtain high turbine efficiency, low turbine weight and bulk, and the maximum propeller efficiency, it has been proposed to employ a high-speed turbine or turbines to drive an electrical generator or generators, which supply current to motors driving one or more propeller shafts. The scheme is attractive, but on careful and unbiased consideration it does not appear to have the prospect of such extensive adoption as some of its advocates would have us believe.

For cargo boats in which first cost and maximum economy are of primary importance, the turbo-electric drive would

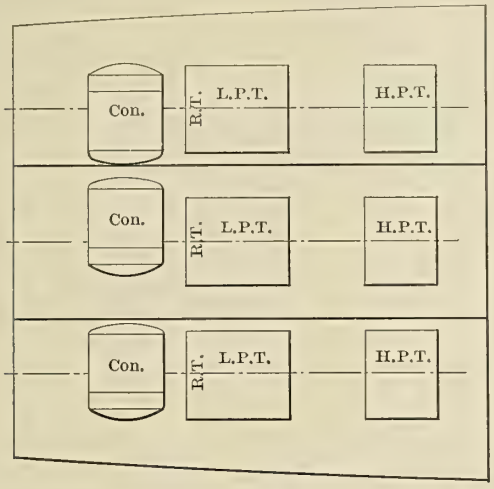



FIG. 7.—ARRANGEMENT OF MACHINERY IN A BATTLESHIP, IMPULSE TURBINES.

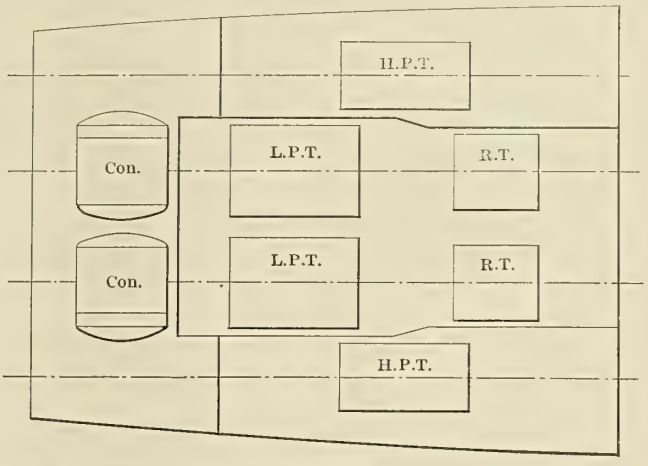



FIG. 8.—ARRANGEMENT OF MACHINERY IN THE MAURETANIA, PARSONS TURBINES.

appear to offer the prospect of a reduced coal consumption, and, moreover, it might be possible to slightly reduce the space occupied by, and the weight of, the total propelling machinery, including boilers, so that the dimensions of a vessel to carry a given weight or bulk of cargo could be very slightly reduced. The reduction in initial cost of hull and the saving in coal during working would not, however, in the writer's opinion, be sufficient to compensate for the extra cost of the electrical machinery. In an estimate which the writer got out for the relative costs of two vessels to carry the same cargo, the one propelled by ordinary reciprocating engines, and the other using the turbo-electric system of propulsion, it appeared that the saving on the hull by adopting the latter system of propulsion would be about $1,947 (£400), but the extra cost of machinery would be about $43,799 (£9,000). The engine power in both cases was, or was equivalent to, 2,000 indicated horsepower. The difference in coal economy cannot be accurately estimated, but it will be obvious that steamship owners will not pay a very large sum on additional outlay for a more complicated installation of machinery unless there is a reasonable chance that the saving in coal will recoup them in 10 or 15 years. It must be remembered that a cargo steamer is usually lying at port during a considerable portion of her time.

As regards the application of the turbo-electric drive to warships, warship machinery is at present much more expensive than that of cargo boats; and the difference in initial cost between a direct-turbine drive and a turbo-electric drive would not be so great as to represent a serious obstacle to the adoption of the latter if it showed decided advantages in other respects. The engine-room weights per maximum horsepower in a warship are, however, so low that the adoption of the turbo-electric drive would very seriously increase them, and although greater economy could no doubt be secured, and the boiler-room weights consequently reduced, it is difficult to see how it would be possible to prevent a decided increase in the total weight of all the propelling machinery. Less coal would be required to be carried with the turbo-electric drive for a given radius of action, but it does not appear that this would compensate for the extra weight of machinery, unless a radius of action were called for much greater than has been usual in the majority of recently-built battleships and cruisers. For torpedo craft the turbo-electric drive is quite out of the question.

It should be noted that in recent British battleships and cruisers very good turbine and propeller efficiencies have been obtained, the high power of the vessels being conducive to the obtaining of a low steam consumption combined with a speed of rotation enabling a very fair propeller efficiency to be obtained.

Vice-Admiral Oram, engineer-in-chief of the British navy, in a recent address to the Junior Institution of Engineers (Great Britain), has stated that the British Admiralty have given careful consideration to the question of the turbo-electric drive, and he lets it be inferred that he does not, at present at least, consider it as desirable to adopt in any British warship.

Fast passenger steamers may be said to be intermediate between warships and cargo boats, as regards the weight of their machinery, so that their case need not be discussed. It appears extremely doubtful if the turbo-electric drive has any chance of adoption for this class of vessels either. For special vessels, however, such, for example, as dredgers, in which the turbines and electric generators might be employed for two purposes, the turbo-electric drive appears to have special advantages, and its adoption in such special cases may be anticipated.

### GEARING.

It is an old idea—which, however, is only now being tried—to gear down the speed of the turbine so that the propeller shaft can rotate at a very much lower speed than the turbine. Gearing for the transmission of great powers is no doubt to be avoided where possible, but the advantages to be derived from its employment on turbine steamships are so great that it occasions some surprise that, until recently, no attempt seems to have been made to gear down a steam turbine for the propulsion of a ship. Experiments are, however, now

being made and will be watched with very great interest. It should be noted that the problem of gearing down the speed of a steam turbine is very different from the problem, which occupied the minds of engineers in the early days of steam propulsion, of gearing up the speed of a reciprocating engine.

HYDRAULIC TRANSMISSION OF POWER.

The Vulcan Company of Stettin, Germany, have recently devoted much time and money to research work on electric, hydraulic and other transmission gear for use on turbine steamships, and their Dr. Föttinger has recently invented an hydraulic reduction and reversing gear whereby it appears possible, with fair efficiency, to transmit the power of a high-speed turbine to a low-speed propeller shaft. The transmission gear comprises a primary water turbine, mounted on the steam-turbine shaft, and a secondary water turbine, mounted on the propeller shaft. The primary water turbine converts the shaft power of the steam turbine into hydraulic power, which is reconverted into shaft power by the secondary water turbine. An efficiency of over 80 percent is said to have been abtained with this hydraulic gear.

SCREW PROPELLERS.

Much progress has been made during the past few years in ascertaining the best design and dimensions of propellers for use on ships propelled by steam turbines. The early turbine steamships had all two or more propellers on some, at least of their shafts—the destroyer *Cobra* had twelve propellers in all—but experience has shown that the best results are obtained with each shaft carrying one propeller only. The research work has no doubt involved much expense, but the results are most valuable. The shaft horsepower required to produce a given speed in a given type of vessel can now be estimated with much more reliance than was the case a few years ago. Higher propeller efficiencies than have yet been recorded for turbine steamships may yet be obtained with further experience and without the necessity of reducing the speed of rotation; but the same efficiency as is now obtained in certain classes of vessel driven by reciprocating engines rotating at 70 to 100 revolutions per minute can hardly be expected.

## Large Marine Gas Engines and Gas Producers.

That producer-gas installations for marine work will be thoroughly investigated by the United States navy is evident from the attitude of H. I. Cone, engineer-in-chief of the Bureau of Steam Engineering, who makes the following recommendation regarding this matter in his annual report:

"The development of large gas-engine machinery operated in connection with gas producers is rapidly progressing. The Bureau is of the opinion that this prime mover is worthy of much more serious investigation and experiment than has yet been given it in our navy.

"It is possible to design a marine plant composed of bituminous coal-gas producers furnishing power to gas engines. There are several such plants already in existence; although they are small, they prove the feasibility of extending this system of developing power to larger installations. Great possibilities for improving the economical operation of machinery are offered by the producer-gas engine combination. We cannot afford to delay development of the gas engine for naval use until commercial gas-engine plants, directly adaptable to naval use, are regularly on the market, and it is, therefore, recommended that special authority be secured in the next appropriation act for the diversion of not more than $250,000 of the appropriation "Steam Machinery" for the purchase and installation of a producer-gas engine plant in one of our colliers, if at any time during the year such an expenditure is deemed advisable."

## BRITISH SHIPBUILDING IN 1909.

When reviewing a year ago the British shipbuilding of 1908 we had to present a sorry record. The cost of building new merchant steamers declined fully 10 percent in that year. It cannot be said to have actually declined further in 1909, because last year the tendency of the prices of material was upwards—at all events in the latter portion of the year. Yet it is probable that some contracts were booked at even lower prices than in 1908, so desirous were the builders in the first six months to obtain work to keep their plants going. In many cases it is admitted that orders were accepted below cost price —at all events without any allowance for establishment charges. Good-sized, well-found cargo-carrying steamers were booked as low as $24.58 (£5.5/–) per ton of deadweight capacity, and some even at $24.33 (£5), if not lower, though in the second half of the year higher prices were exacted. And perhaps the feature of the year has been the number of new contracts for cargo tramps that have been booked, though they do not yet appear in the records of launches.

The output of 1909 is better than that of 1908, and the advance is accounted for principally by cargo steamers. The attitude of the tramp owner is a fair clue to the condition of the shipping industry. Early in 1909 the owners of the better class of tramps began to make inquiries for prices, and soon began to place orders. Since then a good many contracts have been placed, and the shipyards are gradually coming back to normal. A feature of the 1909 shipbuilding trade was the improved relations between employers and men. The experiment in copartnery ownership made by Sir Christopher Furness at Hartlepool is merely an experiment, but the note in all industrial negotiations just now is concilliation. The agreement between the Shipbuilding Employers' Federation and the shipyard trade unions is working smoothly, and has settled a good many disputes that would in previous years have endangered the peace of the trade. The removal of the headquarters of the Engineering Employers' Federation from Glasgow to London will make that organization still more national in character, and a still more powerful influence for peace.

The year has been notable for the performances of the Cunard liners *Lusitania* and *Mauretania,* which have proved themselves capable of fulfilling all the conditions of their contracts and more. They have proved that high speed can be combined with absolute regularity of running. None of the other big lines has yet followed the example of the Cunard Company in the matter of turbines, and the "combination" engine, though it is very successful in the New Zealand steamer *Otaki,* is still in abeyance. On the White Star liner *Laurentic,* in the Canadian service, it is understood to have proved as economical and efficient as the highest type of steamer with twin-screw reciprocating engines. The "combination" engine is, however, only a compromise. We still await a motor that will conjoin the merits of the fast-moving turbine and the slow-moving propeller, and that will dispense with the coal-steam boiler.

CONDITIONS ON THE CLYDE.

Turning first to the Clyde as the premier shipbuilding river of the kingdom, we find that some of the ground lost in 1908, when the production fell from the record of 620,000 tons to 355,000, was regained in 1909 by an increased tonnage of about 48,000. This is not very much, but enough to encourage the belief that 1907 was the bottom of the period of depression, and that coming years will see a further improvement. The

figures for 1909, while better than those of previous year, are (except 1908) the lowest since 1897, and they are less by 215,000 tons than the record of 1907. Several of the yards were idle for two or three months, but as trade improved they obtained orders, and as the year closed they had practically all, with one exception, something on the stocks. There were no labor troubles throughout the year. As to the output, I again adopt the very complete statistics collected by the *Glasgow Herald,* which I know to be reliable.

The following table gives a summary of the work of each Clyde firm and also their tonnage for 1909:

| | 1909 Tons. | 1908 Tons. |
|---|---|---|
| Russell & Co | 55,519 | 48,619 |
| Wm. Denny & Bros | 33,391 | 20,875 |
| Wm. Hamilton & Co | 28,859 | 11,386 |
| The Fairfield Company | 27,688 | 17,520 |
| Charles Connell & Co | 25,468 | 30,698 |
| Alex. Stephen & Sons | 21,353 | 19,904 |
| Scotts' Shipbuilding Co | 21,259 | 4,171 |
| A. MacMillan & Son | 19,637 | 9,715 |
| Greenock & Grangemouth Company | 17,526 | 6,524 |
| Barclay, Curle & Co | 15,250 | 38,810 |
| Clyde Shipbuilding Co | 13,305 | 7,201 |
| London and Glasgow Co | 12,129 | ..... |
| A. Rodger & Co | 11,339 | 1,801 |
| Napier & Miller | 11,076 | 16,211 |
| Caird & Co | 10,883 | 16,723 |
| John Brown & Co | 10,154 | 15,300 |
| D. & W. Henderson & Co | 7,625 | 17,805 |
| Wm. Beardmore & Co | 6,000 | 11,533 |
| Ailsa Shipbuilding Co | 5,980 | 5,985 |
| Wm. Simons & Co | 5,870 | 7,933 |
| Fleming & Ferguson | 5,600 | 5,050 |
| R. Duncan & Co | 5,222 | ..... |
| Lobnitz & Co | 4,605 | 6,663 |
| Yarrow & Co | 2,488 | 2,813 |
| Mackie & Thomson | 2,725 | 2,157 |
| Ferguson Bros | 2,480 | 3,086 |
| John Fullerton & Co | 2,438 | 1,883 |
| Alley & MacLellan | 2,430 | 2,930 |
| The Campbeltown Co | 2,404 | ..... |
| Mechan & Sons | 1,645 | 4,205 |
| A. & J. Inglis | 1,561 | 6,777 |
| The Ardrossan Co | 1,464 | 1,517 |
| D. J. Dunlop & Co | 1,254 | 2,308 |
| George Brown & Co | 1,193 | 978 |
| Scott & Sons | 1,022 | 1,629 |
| D. M. Cumming | 990 | 157 |
| Bow, McLachlan & Co | 934 | 2,370 |
| Murdoch & Murray | 617 | 282 |
| Ritchie, Graham & Milne | 540 | 377 |
| John Reid & Co | 414 | 412 |
| William Fife & Son | 199 | 297 |
| P. Macgregor & Sons | 157 | 314 |
| Other Firms | 491 | 577 |
| | 403,187 | 355,586 |

Clyde builders turn out many kinds of craft, and the following table shows the types of vessels launched during the year:

| | No. Tons. | |
|---|---|---|
| Screw Steamer | 139 | 348,741 |
| Warships | 13 | 16,974 |
| Dredgers | 23 | 9,579 |
| Lighters and Barges | 63 | 8,954 |
| Turbine Steamers | 2 | 4,104 |
| Pontoons, docks, etc | 3 | 3,250 |
| Train Ferries | 2 | 3,032 |
| Hopper Steamers | 4 | 2,980 |
| Tugs | 10 | 1,609 |
| Paddle Steamers | 4 | 1,539 |
| Rock Cutters | 7 | 682 |
| Fishing Steamers | 6 | 648 |
| Motor Boats | 54 | 543 |
| Sailing Yachts | 20 | 333 |
| Steam Yachts | 2 | 189 |
| Launches | 2 | 30 |
| | 354 | 403,187 |

The year was not one of notable merchant vessels, either in size or design. There were seven launched of more than 10,000 tons each, all representing the art of the builders and engineers at its best, but none marking an epoch. The following were some of the notable ships built in United Kingdom in 1909:

| Vessel. | Tons. | Builders of Vessel. |
|---|---|---|
| Balmoral Castle | 13,100 | Fairfield Co. |
| Orvieto | 12,130 | Workman, Clark & Co. |
| Osterley | 12,129 | London & Glasgow Co. |
| Otranto | 12,124 | Workman, Clark & Co. |
| Mantua | 10,883 | Caird & Co. |
| Ruahine | 10,758 | Wm. Denny & Bros. |

There is not much of novelty in the Clyde details. Russell & Company turned out the largest tonnage on the river, improving on 1908 by about 7,000 tons. Denny & Bros. launched thirty-one vessels of 33,394 tons, a considerable proportion of the total being steamers for the Far East. They had only three turbine vessels—the destroyer *Maori* and two railway steamers for service on the Fleetwood and Belfast route. William Hamilton & Company launched four vessels on the *Isherwood* principle, for which the firm holds a license. The Fairfield Company launched three Queenborough-Flushing Channel steamers, one second-class cruiser, one destroyer, and one Union-Castle mail liner. John Brown & Company launched three destroyers, a paddle steamer for the Thames, and a big twin-screw steamer for the Huddart-Parker Company, of Melbourne. Yarrow & Company, specialists in light shipbuilding, turned out eight warships of the smaller types for four foreign governments, as well as boilers for a British destroyer and internal-combustion engines for two Austro-Hungarian gunboats.

The tonnage of warships and turbine steamers was low, but in the case of warships the average will be kept up by the output of 1910. The Clyde obtained the contract for only one of the "contingent" battleships, but it received a large share of the work which the Admiralty allocated during last year. The battleship contract went to Beardmore's, who are completing the second-class cruiser *Gloucester* and laying down an improved sister ship. At Clydebank, John Brown & Company have launched three of their six destroyers, and have three others, as well as the cruiser *Bristol,* on the stocks. At Fairfield the cruiser *Glasgow* is completing, one destroyer has been launched, and there are five to come for the British Government and two for the Commonwealth of Australia. The London & Glasgow Shipbuilding Company have on hand the destroyer *Rattlesnake* and an improved Bristol cruiser. The engines for the former have been made by Yarrow & Company, and those for the latter by John Brown & Company. A destroyer placed recently with A. & J. Inglis is taking shape on the berth. Yarrow & Company have two of ten Brazilian destroyers and some other light craft to launch. At Dumbarton, Denny & Company have completed the large destroyer *Maori,* and have three others still to launch, as well as one for Australia. At Greenock, Scotts' Company are making progress with the battleship *Colossus,* the order for which was placed with them last summer. Of authorized Admiralty contracts not yet allocated there are the two Colonial battleships.

There are not many merchant vessels of outstanding importance at present building on the Clyde. The Fairfield Company have only destroyers on the stocks, the London & Glasgow Company have no mercantile work, but at Pointhouse, A. & J. Inglis have a "MacBrane" Line steamer, an Italian railway steamer, and a passenger steamer for Australia. D. & W. Henderson have three vessels, each of 7,000 tons; Mackie & Thomson two trawlers and one small Booth Line steamer; Alex. Stephen & Sons, three steamers of 19,000 tons aggregate; Barclay, Curle & Company, three; Charles Connell & Company, a Donaldson liner and one other vessel, and John Brown & Company, a Harwich & Hook of Holland, steamer, and a steam yacht. At Renfrew, Lobnitz & Company are building a rock-cutter, a large hopper barge, a stern-wheeler, a gold dredger and a small barge, and Simons & Company two

dredgers. Napier & Miller, Old Kilpatrick, have four steamers on the stocks, making altogether about 11,600 tons. At Dumbarton, Denny & Bros. have on hand a steamer for the New Zealand Shipping Company, and a large vessel for P. Henderson & Company's line, and MacMullan & Son have two on the stocks and two to lay down, making altogether for Dumbarton a total of about 34,000 tons. The work is now fairly well distributed, but some of the smaller establishments have very little on hand. The yards in Greenock and Port-Glasgow have orders representing over 100,000 tons, but the work there has not been well distributed. Several of the eleven firms have almost fully-occupied berths where others have little or none. H. M. S. *Colossus* is in progress in the yard of Scotts' Company. The busiest firms are Russell & Company and William Hamilton & Company, more than half of the estimated tonnage being in these two yards. In both cases the vessels are cargo steamers for service in various parts of the world. Quite a number building by William Hamilton & Company are on the Isherwood system. On the lower Firth of Clyde there is not very much doing. The Ailsa Shipbuilding Company are building at Ayr and Troon a passenger steamer of 1,850 tons, a ferry steamer of about 400, and a cargo steamer of 1,450. The Ardrossan Company have on hand a paddle steamer of 455 tons and a cargo steamer of 750 tons, and the Campbeltown Company four steamers of about 13,000 tons. Altogether the work on hand on the river amounts to about 250,000 tons of merchant shipping and 73,000 tons of warships, a total of 323,000 tons, as compared with a little over 300,000 in 1908.

REPORTS FROM THE ENGLISH DISTRICTS.

The English districts show better than at the end of the previous year. There has not been anything like the revival to bring the industry on the Northeast Coast back to normal; but there has been some recovery from the depression of 1908. There is a further decrease of tonnage on the Tyne—from 336,000 in 1907 to 210,000 in 1908, and to 199,000 in 1909, but the Wear advanced from 85,000 to 132,000, the Tees and Hartlepool from 96,000 to 122,000, the Mersey from 39,000 to 85,000, and the Humber from 21,000 to 24,000 tons. The net English increase is nineteen vessels, 115,547 tons, and 194,200 indicated horsepower. The improving conditions on the Wear and Tees are noteworthy, as these districts were harder hit by the depression than any others. They depend almost entirely on the building of cargo steamers, and they have nothing in the way of liners or special craft to keep them going. An advance of nearly 200,000 indicated horsepower in marine engines constructed occurred on the Tyne and at Barrow and Birkenhead. The increase of 84,000 on the Tyne was in destroyers, built by Palmer's Company, cruiser turbines by the Wallsend Slipway Company, warship work done by the Parsons Company, and the increased number of steamers built at their own yard, which Swan, Hunter & Wigham Richardson have engined. At Barrow and Birkenhead warship machinery is also the distinguishing feature of the engineering returns. The following table summarizes the output of the several English districts:

| | 1909 | | | 1908 | | |
|---|---|---|---|---|---|---|
| | Vessel. | Tons. | I. H. P. | Vessel. | Tons. | I. H. P. |
| The Tyne | 112 | 199,307 | 262,993 | 115 | 210,110 | 178,665 |
| The Wear | 57 | 132,633 | 95,556 | 40 | 85,351 | 81,803 |
| Tees and Hartlepool | 46 | 122,733 | 69,025 | 38 | 96,001 | 66,489 |
| Mersey to Solway | 92 | 85,228 | 164,950 | 95 | 39,232 | 68,836 |
| Royal Dockyards | 6 | 46,612 | ..... | 5 | 43,060 | ..... |
| The Humber | 72 | 24,414 | 35,375 | 98 | 21,714 | 27,720 |
| English Channel | 104 | 9,920 | 68,101 | 106 | 10,237 | 66,504 |
| The Thames | 96 | 7,053 | 11,618 | 112 | 9,881 | 23,723 |
| Bristol Channel | 57 | 5,399 | 762 | 14 | 2,106 | 443 |
| | 642 | 633,299 | 708,383 | 623 | 517,752 | 514,183 |

Notwithstanding improving trade the Tyne has failed to improve on its output for 1908, and as the tonnage for that year was a good deal less than that of 1907, the total for 1909 was much under the capacity of the river. Swan, Hunter & Wigham Richardson again lead, with an output of 71,000 tons, somewhat less than 1908, but sufficient to give them second place for the world. In the tonnage of the district there are a cruiser, two scouts and six torpedo boat destroyers, while there is a large amount of naval work still on hand. In engineering, the Wallsend Slipway Company lead with 55,800 indicated horsepower, included in which are the turbines for a cruiser. The Parsons Company have constructed only warship turbines during the year—for the Brazilian scouts built at Elswick and the battleship *St. Vincent,* built at Portsmouth dockyard. Prospects generally are improving, and there is a fair amount of work on hand. The following shows the output of each of the Tyne yards:

| | Vessel. | 1909 | | 1908 | |
|---|---|---|---|---|---|
| | | Tons. | I. H. P. | Tons. | I. H. P. |
| Swan Hunter, etc. | 23 | 71,000 | 22,650 | 60,266 | 7,750 |
| The Northumberland Co. | 9 | 41,472 | ..... | 19,028 | ..... |
| Hawthorn, Leslie & Co | 6 | 17,230 | 41,500 | 12,810 | 34,500 |
| Armstrong Whitworth | 10 | 15,964 | ..... | 51,384 | ..... |
| John Readhead & Sons | 4 | 15,352 | 7,500 | 7,844 | 5,000 |
| Wood, Skinner & Co. | 5 | 8,590 | ..... | 4,832 | ..... |
| Tyne Shipbuilding Co. | 3 | 8,423 | ..... | 10,512 | ..... |
| Blyth Shipbuilding Co. | 10 | 6,276 | ..... | 6,725 | ..... |
| T. Stephenson & Co. | 1 | 4,386 | ..... | 5,940 | ..... |
| Smith's Dock Co. | 20 | 4,322 | ..... | 6,151 | ..... |
| Palmers Shipbuilding Co | 3 | 1,620 | 31,300 | 7,149 | 16,100 |
| J. P. Rennoldson & Sons | 6 | 1,553 | 5,024 | 745 | 3,155 |
| Wm. Dobson & Co. | 1 | 1,387 | ..... | 14,702 | ..... |
| J. T. Eltringham & Co. | 3 | 937 | ..... | 1,154 | ..... |
| Hepple & Co. | 8 | 795 | 1,740 | 868 | 810 |
| Wallsend Slipway Co. | ..... | ..... | 55,800 | ..... | 33,175 |
| N. Eastern Marine Co. | ..... | ..... | 46,742 | ..... | 44,240 |
| Parsons Turbine Co. | ..... | ..... | 36,500 | ..... | 15,000 |
| Shields Engineering Co. | ..... | ..... | 7,360 | ..... | 8,750 |
| G. T. Grey | ..... | ..... | 5,020 | ..... | 10,035 |
| Baird Bros. | ..... | ..... | 1,800 | ..... | 150 |
| Total | 112 | 199,307 | 262,996 | 210,110 | 178,665 |

The Tyne is, of course, the birthplace of the turbine. For marine purposes engines of this type were fitted to the historic *Turbinia* in 1894 by the inventor, the Hon. C. A. Parsons. Turbines of the largest size have been constructed in different engine works in the district for battleships and mercantile vessels, including those for the *Mauretania,* built by the Wallsend Slipway & Engineering Company. The same firm has machinery for the battleship *Orion* now in hand. Recent orders include turbine machinery for the new Armstrong Dreadnought from Hawthorn, Leslie & Company, who have already engined H. M. S. *Temeraire* and *Collingwood.* Boilers and reciprocating engines of the largest size are constructed by several firms, while the premises of the North Eastern Marine Engineering Company, which claims the largest output of marine boilers and reciprocating engines of any firm in the world, are situated at Wallsend-on-Tyne.

The majority of the Wear yards did a good deal better than 1908, although there seems to be a falling off in turret steamers, of which there are only two in Messrs. Doxford's list. This firm also launched the self-discharging collier *Pallion,* equipped with belt-discharging appliances which deliver the coal into barges. Another interesting vessel is the *Montoria,* built by Osborne, Graham & Company, on a new principle—that of longitudinally grooved sides, which enable the vessel to steam at a given speed with less horsepower than would otherwise have been required. The Wear tonnage for the year shows a marked improvement over 1908, which was less than a third of the year before, and prospects are improving. Quite a number of orders were booked in the autumn, and most of the yards are now fairly busy. The following shows the output of the several Wear yards:

SHIPBUILDING ON THE WEAR.

| | Vessel. | 1909 | | 1908 | |
|---|---|---|---|---|---|
| | | Tons. | I. H. P. | Tons. | I. H. P. |
| Wm. Doxford & Sons | 8 | 28,393 | 13,650 | 20,271 | 8,500 |
| Short Bros | 8 | 20,237 | ..... | 10,054 | ..... |
| J. L. Thompson & Sons | 5 | 19,269 | ..... | 10,465 | ..... |
| The Sunderland Co | 6 | 13,706 | ..... | 3,296 | ..... |
| R. Thompson & Sons | 6 | 13,488 | ..... | 5,301 | ..... |
| Bartram & Sons | 2 | 7,433 | ..... | 3,738 | ..... |
| S. P. Austin & Son | 5 | 7,029 | ..... | 1,725 | ..... |
| John Crown & Sons | 6 | 6,583 | ..... | 2,640 | ..... |
| Osbourne, Graham & Co | 5 | 5,950 | ..... | 5,317 | ..... |
| W. Pickersgill & Sons | 3 | 5,090 | ..... | 2,968 | ..... |
| John Blumer & Co | 1 | 2,838 | ..... | 6,309 | ..... |
| J. Priestman & Co | 2 | 2,617 | ..... | 3,513 | ..... |
| Sir James Laing & Sons | ..... | ..... | ..... | 9,754 | ..... |
| N. E. Marine Company | ..... | ..... | *37,155 | ..... | *23,440 |
| John Dickinson & Sons | ..... | ..... | 19,311 | ..... | 11,683 |
| George Clark, Ltd | ..... | ..... | 10,050 | ..... | 22,400 |
| Richardsons, Westgarth & Co | ..... | ..... | *9,800 | ..... | *6,900 |
| MacColland Pollock | ..... | ..... | 5,590 | ..... | 8,880 |
| | 57 | 132,633 | 95,556 | 85,351 | 81,803 |

* Sunderland only.

The revival in trade also affected the Tees and Hartlepool district, though not quite so strongly as on the Wear. The total for the year, while better than that of 1908, is only about half that of 1907. The following shows the output of the several Tees and Hartlepool yards:

| | Vessel. | 1909 | | 1908 | |
|---|---|---|---|---|---|
| | | Tons. | I. H. P. | Tons. | I. H. P. |
| William Gray & Co | 8 | 30,517 | 17,300 | 25,071 | 17,764 |
| Irvine's Shipbuilding Co | 11 | 30,126 | ..... | 12,549 | ..... |
| Ropner & Sons | 4 | 16,939 | ..... | 5,005 | ..... |
| Richardson, Duck & Co | 8 | 15,606 | ..... | 7,519 | ..... |
| Sir Raylton Dixon & Co | 6 | 12,661 | ..... | 26,146 | ..... |
| Craig, Taylor & Co | 4 | 9,368 | ..... | 5,105 | ..... |
| R. Craggs & Sons | 2 | 4,972 | ..... | 10,935 | ..... |
| W. Harkness & Son | 3 | 2,544 | ..... | 3,731 | ..... |
| Richardsons, Westgarth & Co | ..... | ..... | 28,650 | ..... | 24,550 |
| Blair & Co | ..... | ..... | 23,075 | ..... | 24,175 |
| | 46 | 122,733 | 69,025 | 96,061 | 66,489 |

The following shows detailed output of the Northwest yards:

| | Vessel. | 1909 | | 1908 | |
|---|---|---|---|---|---|
| | | Tons. | I. H. P. | Tons. | I. H. P. |
| Vickers, Sons & Maxim | 6 | 60,200 | 122,110 | 12,487 | 58,850 |
| Cammell, Laird & Co | 30 | 19,707 | 40,234 | 19,142 | 7,520 |
| W. J. Yarwood & Sons | 12 | 1,789 | 396 | 1,744 | 806 |
| Lytham Shipbuilding Co | 17 | 1,597 | 1,690 | 1,637 | 1,660 |
| Abdella & Mitchell | 2 | 170 | 520 | 1,230 | ..... |
| Other Firms | 25 | 1,765 | ..... | 2,992 | ..... |
| | 92 | 85,228 | 164,950 | 39,232 | 68,836 |

OUTPUT OF THE ADMIRALTY DOCKYARDS.

The output of the Admiralty Naval Dockyards was 46,612 tons displacement in six vessels, as compared with 43,060 tons displacement in 1908. The details are summarized below:

| Vessel. | Type. | Tons. | I. H. P. | Built at |
|---|---|---|---|---|
| Neptune | Battleship | 20,250 | 27,000 | Portsmouth. |
| Indefatigable | Arm. Cruiser | 19,000 | 43,000 | Devonport. |
| Bellona | Scout Cruiser | 3,360 | 18,000 | Pembroke. |
| Blanche | Scout Cruiser | 3,360 | 18,000 | Pembroke. |
| Two Vessels | Submarines | 642 | ..... | Chatham. |
| | | 46,612 | | |

Machinery all contract.

In the following table the production of each of the establishments is compared with the totals for the nine preceding years. Sheerness is not now a building yard, but does a great deal of overhauling and fitting torpedo craft. The Medway yard at Chatham has built no armored vessel since 1906, but does heavy repairs and refits, and last year constructed submarines:

| Year. | Portsmouth | | Chatham | | Pembroke | | Devonport | | Sheerness | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Ves. | Tons. | Ves. | Tons. | Ves. | Tons. | Ves. | Tons. | Ves. | Tons. |
| 1909 | 1 | 20,250 | 2 | 612 | 2 | 6,720 | 1 | 19,000 | .. | ..... |
| 1908 | 1 | 19,250 | 2 | 630 | 1 | 3,300 | 1 | 19,250 | .. | ..... |
| 1907 | 1 | 18,600 | .. | ..... | 1 | 14,600 | 1 | 18,600 | .. | ..... |
| 1906 | 1 | 17,900 | 1 | 14,600 | .. | ..... | 1 | 14,600 | .. | ..... |
| 1905 | .. | ..... | 1 | 16,350 | 1 | 13,550 | 1 | 16,350 | .. | ..... |
| 1904 | 2 | 32,700 | 1 | 10,850 | 1 | 13,550 | .. | ..... | .. | ..... |
| 1903 | 1 | 9,800 | .. | ..... | .. | ..... | 1 | 16,350 | 2 | 2,140 |
| 1902 | .. | ..... | 2 | 20,880 | 1 | 9,800 | 2 | 20,880 | .. | ..... |
| 1901 | 1 | 9,800 | 1 | 14,000 | 2 | 23,900 | 1 | 14,000 | 3 | 3,210 |
| 1900 | 1 | 2,200 | .. | ..... | .. | ..... | .. | ..... | 3 | 3,030 |

The battleship *Orion* is on the stocks at Portsmouth, and the armored cruiser *Lion* on the stocks at Devonport, the scout cruiser *Blonde* on the stocks at Pembroke, and two submarines at Chatham.

CONSTRUCTION IN IRISH YARDS.

We turn now to the Irish shipyards, and find that 1909 was one of the years in which Harland & Wolff do not appear among the first two or three firms in the volume of tonnage launched. The place at the top is now taken by Workman, Clark & Company, although their output of 88,952 tons is short of the figures which usually takes first place. Meantime Harland & Wolff's yard has been arranged to make room for the two 45,000-ton White Star Liners *Olympic* and *Titanic,* both of which will probably figure in the 1910 return of launches; and besides these the firm have quite a number of large liners on hand. The following shows the output of the Irish yards:

| | Vessel. | 1909 | | 1908 | |
|---|---|---|---|---|---|
| | | Tons. | I. H. P. | Tons. | I. H. P. |
| Workman, Clark & Co | 16 | 88,952 | 76,550 | 50,303 | 38,400 |
| Harland & Wolff | 6 | 29,708 | 46,250 | 106,528 | 65,840 |
| Dublin Dockyard Co | 5 | 1,808 | ..... | 1,574 | ..... |
| Larne Shipbuilding Co | 8 | 400 | ..... | 221 | ..... |
| Tyrrel & Sons | 2 | 36 | ..... | ..... | ..... |
| MacColl & Co | ..... | ..... | 950 | ..... | 1,250 |
| | 37 | 120,904 | 123,750 | 158,626 | 105,490 |

The Dublin Dockyard Company, it should be noted, launched recently a noteworthy twin-screw coal elevator for the London & North Western Railway Company, for special service in Holyhead Harbor. This vessel, which is named *Herald,* is for coaling the steamers of the company's fleet, about twenty of which require to be coaled daily. It is calculated that the coaling of each vessel's bunkers from the new steamer will occupy only from ten to twenty minutes.

SUMMARY.

We can now sum up the production of the United Kingdom. The following table shows increases of tonnages and horsepower in Scotland and England, decreased tonnage and increased horsepower in Ireland:

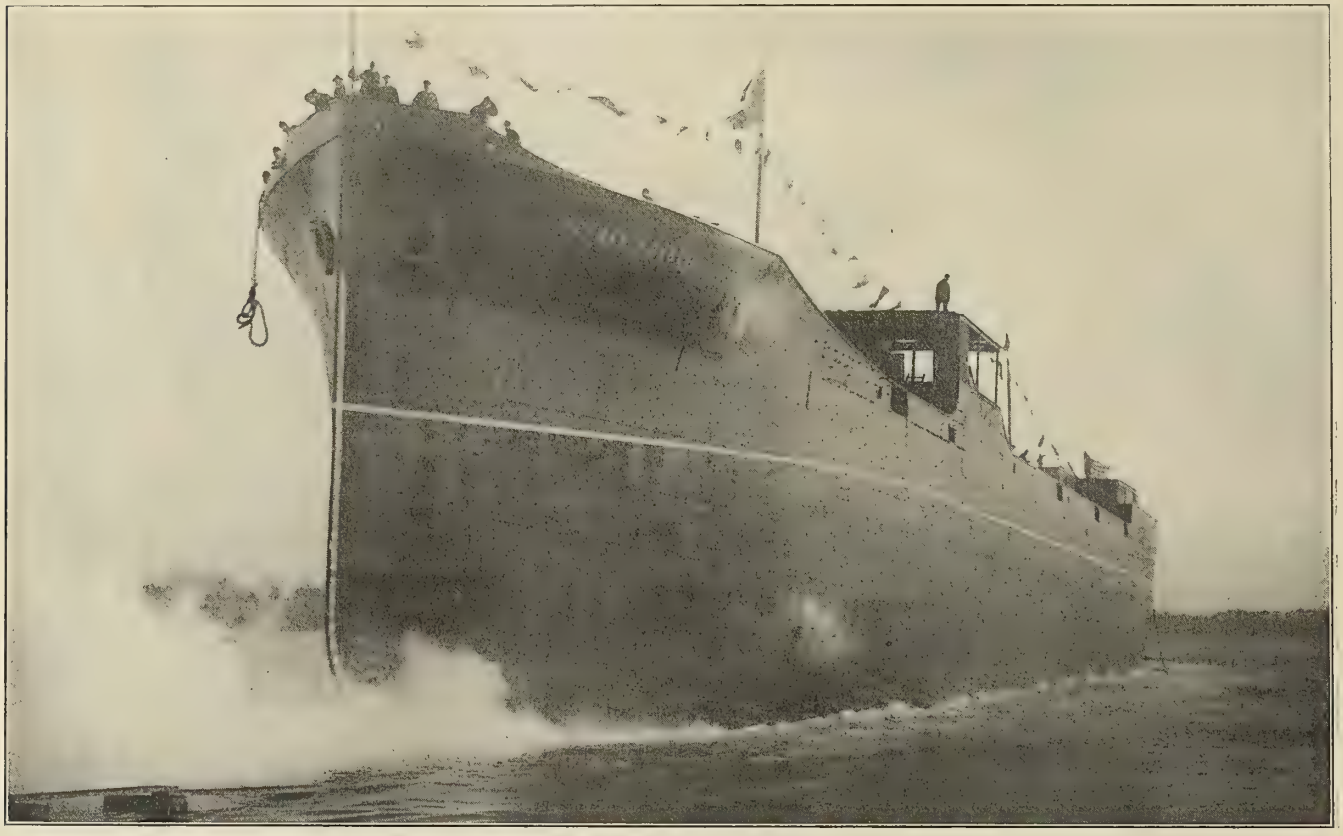
| | 1909 | | | 1908 | | |
|---|---|---|---|---|---|---|
| | Vessel. | Tons. | I. H. P. | Vessel. | Tons. | I. H. P. |
| Scotland | 418 | 427,325 | 638,310 | 680 | 400,194 | 528,872 |
| England | 642 | 633,299 | 708,383 | 623 | 517,752 | 514,183 |
| Ireland | 37 | 120,904 | 123,750 | 22 | 158,626 | 105,490 |
| U. K. Totals | 1097 | 1181528 | 1470443 | 1325 | 1076572 | 1148545 |

## S. S. HERMAN FRASCH.

The *Herman Frasch* is a single-screw steamship, constructed by the Fore River Shipbuilding Company, Quincy, Mass., to the highest class in the American Bureau of Shipping and British Corporation Registry. The vessel is of the single-deck type, constructed with Simpson patent topside tanks, forming three large self-trimming cargo holds, each operated by twin hatchways having the De Russett patent covers.

The after part is built up to form a long poop with Liverpool house on top, in which are berthed the engineer officers and their assistants. A short bridge, with bridge house, is arranged forward of amidships, with quarters for the captain, navigating officers, saloon, chart room, pilot house. etc., while forward the vessel is built up to form a topgallant forecastle, with anchor-handling appliances.

The *Herman Frasch* has a straight stem and semi-elliptical stern, has the machinery arranged aft, and is rigged with three pole masts, from the tops of the forward two of which there is rigged a wireless telegraphy outfit.



LAUNCH OF THE HERMAN FRASCH.

The vessel has been designed specially for the carriage and operation of bulk freight expeditiously, and for this purpose is fitted with kingposts, operating twin booms, on which are carried the Spencer-Miller patent marine transfer, capable of discharging the cargo at a rate of over 300 tons per hour.

The principal dimensions are as follows:

| | |
|---|---|
| Length over all | 361 feet. |
| Length between perpendiculars | 345 feet. |
| Breadth | 48 feet 3 inches. |
| Depth | 30 feet. |
| Draft | 23 feet 6 inches. |
| Load displacement | 8,770 tons. |
| Indicated horsepower | 2,100 |
| Speed | 10.5 knots. |

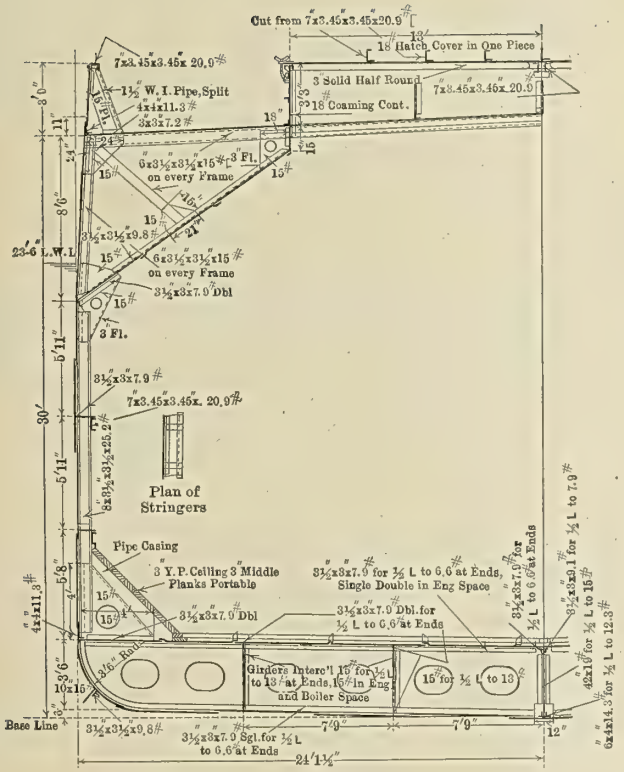
### THE HULL.

The keel plate is 47 inches wide by 35 pounds for half the length amidships and aft, reduced to 29 pounds at the forward end. The center keelson, which is continuous, is 42 inches by 19 pounds for half the length amidships, reduced to 15 pounds at the ends. In the machinery space it is 70 inches by 19 pounds. The double angles joining the center keelson to the keel plate are 6 inches by 4 inches by 14.3 pounds for half the length, reduced to 12.3 pounds at the ends. There are also double angles at the top of the center keelson, 3½ inches by 3 inches by 9.1 pounds amidships, reduced to 7.9 pounds at the ends.

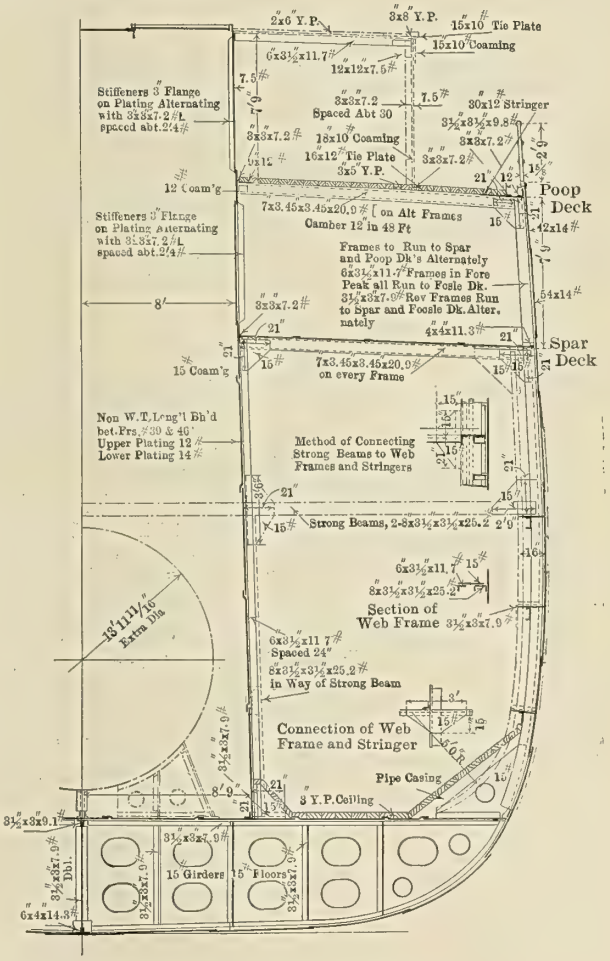
In addition to the center keelson there are two intercostal longitudinals on each side of the center keelson. These are of 15-pound plate for half the length amidships, reduced to 13 pounds at the ends. The floors are continuous, of 15-pound plate for half the length amidships, and of 13-pound plate at the ends. There are five water-tight bulkheads, the lower half being constructed of 14-pound plate and the upper half of 12-pound plate. There are both vertical and horizontal stiffeners. The vertical stiffeners are 7-inch by 3.45-inch by 3.45-inch by 20.9-pound channels, spaced 24 inches apart. There are three horizontal stiffeners on each bulkhead, of the same-size channel bars as the vertical stiffeners. The bulkheads are bracketed to the inner bottom, but are joined to the deck simply by double angles.

The frames, up to the top-side tanks, are 8-inch by 3½-inch by 3½-inch by 25.2-pound channel bars, spaced 24 inches apart throughout. In the top-side tanks they are 6-inch by 3½-inch by 3½-inch by 15-pound channels. In the peak tanks the frames consist of 6-inch by 3½-inch by 11.7-pound angles, with 3½-inch by 3-inch by 7.9-pound reverse bars. The frames are bracketed to the inner bottom by 15-pound brackets, and midway between the margin plate and top-side tank there is a

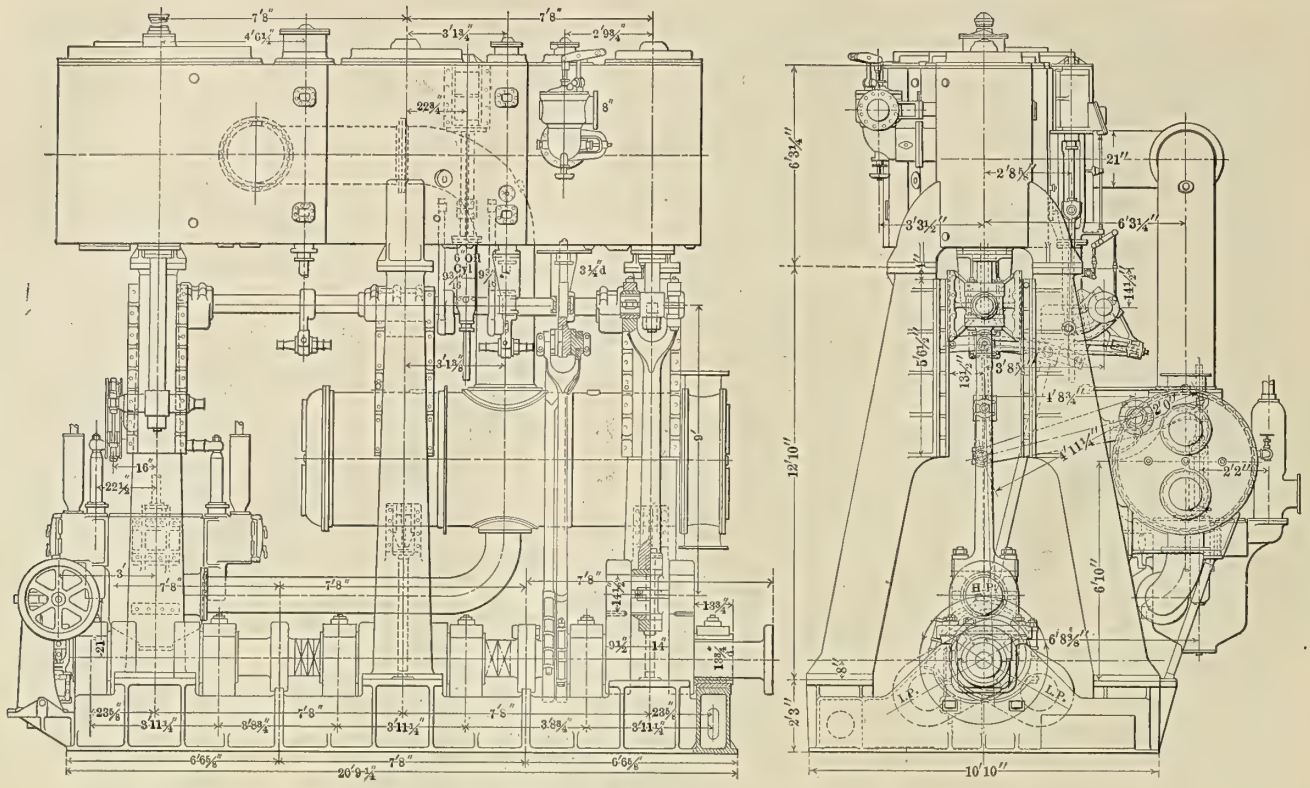
INTERIOR OF ONE OF THE MAIN HOLDS OF THE HERMAN FRASCH.




MIDSHIP SECTION.




SECTION THROUGH THE BOILER ROOM.



THE MAIN ENGINE WITH CONDENSER AND DIRECT-CONNECTED AIR AND BILGE PUMPS.

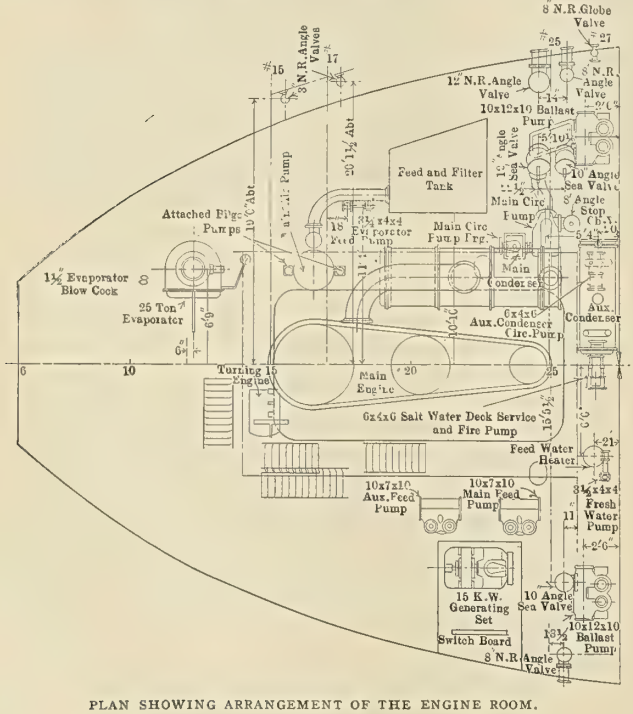
15-pound intercostal stringer, joined to the shell plating by 3½-inch by 3-inch by 7.9-pound single intercostal angles, and carrying at the inner edge a continuous 7-inch by 3.45-inch by 3.45-inch by 20.9-pound channel.

The garboard strake of plating is 65 inches by 23 pounds for half the length amidships, reduced to 18 pounds at the ends. The bottom plating is 65 inches by 21 pounds for half the length amidships, reduced to 18 pounds at the ends. The bilge strake is 25 pounds for half the length amidships, reduced to 18 pounds at the ends. The side plating is 60 inches by 23 pounds for half the length amidships, reduced to 18 pounds at the ends, while the sheer strake is 42 inches by 34 pounds for half the length amidships, reduced to 18 pounds at the ends.

The top-side tank is formed of 14-pound plate for half the length amidships, reduced to 12 pounds at the ends. The plating is riveted to 3½-inch by 3½-inch by 9.8-pound angle-bars, spaced on every frame. These bars are braced to the main deck beam brackets by angle-bars, 6 inches by 3½ inches by 3½ inches by 15 pounds on every frame.

The spar deck beams consist of 6-inch by 3½-inch by 3½-inch by 15-pound channels on every frame. The spar deck is a complete steel deck throughout, the stringer plate being 48 inches by 28 inches for half the length amidships, reduced to 36 inches by 20 pounds at the ends. The deck plating is 14 pounds for half the length, reduced to 12 pounds at the end, while the plating next to the hatches is 18 pounds amidships, reduced to 16 pounds at the ends.

There are six cargo hatches, 14 feet by 26 feet, two to each hold.

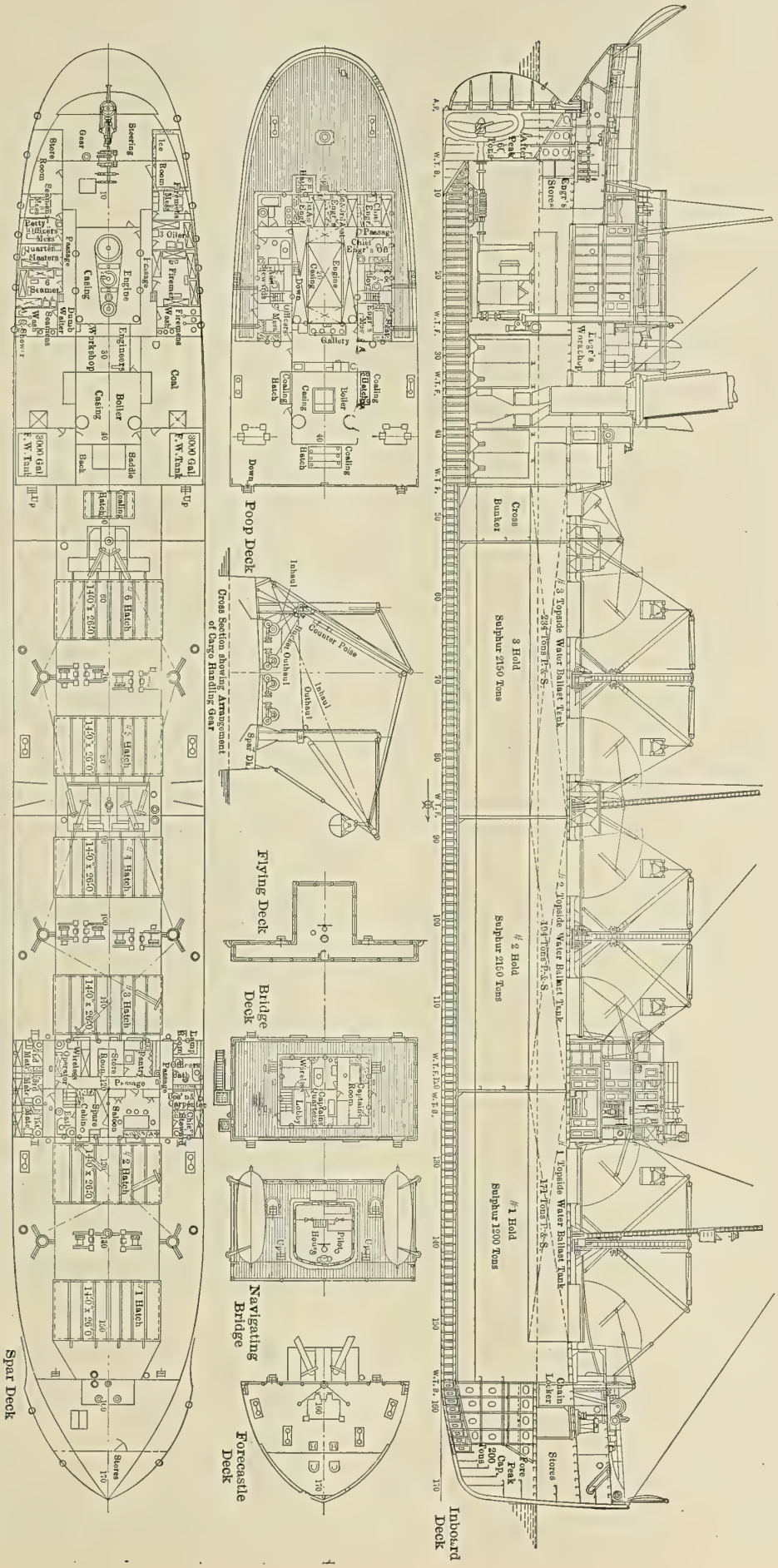



PLAN SHOWING ARRANGEMENT OF THE ENGINE ROOM.

### THE BOILERS.

Steam is supplied by three single-ended Scotch boilers, designed for a working pressure of 180 pounds per square inch. The boilers are 13 feet 9 inches mean diameter and 11 feet 10 inches long. Each has three corrugated furnaces, 42 inches inside diameter, leading to separate combustion chambers. The grates are 4 feet 9 inches long, and the grate area for each boiler 50 square feet. There are three hundred and one, 2½ inches outside diameter, .12 inches thick, ordinary charcoal iron tubes; forty-three, 2½ inches outside diameter, stay tubes, .259 inch thick at the bottom of the thread, and twenty-four, 2½ inches outside diameter, marginal stay tubes, .38 inch thick to the bottom of the thread, making a total of 368 tubes in each boiler. The heating surface of the tubes is 1,821 square feet; of the furnaces, 132 square feet; of the combustion chambers, 214 square feet, making a total of 2,167 square feet. The ratio of heating surface to grate area is, therefore, 43.4 to 1. The tube area in each boiler is 9.82 square feet, mkaing a ratio of grate area to tube area of 5.09.

The shells of the boilers are in two courses of 1 5/16-inch




INBOARD PROFILE AND DECK PLANS OF THE HERMAN FRASCH.

plate. The girth seams are double-riveted lap joints, with 1¼-inch diameter rivets spaced about 3⅞ inches. The longitudinal joints are triple-riveted, double-butt strap joints, fastened with 1¼-inch rivets, the inner rows being spaced 4 inches and the outer 8 inches between centers. The efficiency of the plate in this joint is 83.6 percent and of the rivets 92.7 percent. The lower half of the back head is 15/16 inch thick and the upper half ⅝ inch. The front head is 15/16 inch thick. Above the tubes the heads are stayed by nineteen through stays, 2 7/16 inches diameter. There are also two of the same sized stays below the tubes above the center furnace, while below the furnace, between the center and outer ones, on each side are three 2 7/16-inch through stays, and above the outer furnaces on each side one 1½-inch stay. The stay-bolts in the combustion chamber are 1⅝ inches diameter, spaced 7¾ inches, both vertically and horizontally.

THE MAIN ENGINES AND AUXILIARIES.

The main engines consist of one set of triple-expansion engines, with cylinders 25 inches, 41 inches and 68 inches diameter and 48-inch stroke.

The condenser, which is mounted on brackets on the columns of the engine, is cylindrical, 4 feet in diameter and 11 feet long between the tube sheets. It has a total cooling surface of 3,010.84 square feet. The air pump, 24 inches by 20 inches, and two bilge pumps, 4½ inches by 20 inches, are driven direct from the low-pressure cross-head. There is a centrifugal circulating pump, driven by an 8-inch by 8-inch engine, with a 12-inch suction and discharge.

The auxiliaries include two high-pressure feed pumps of the Worthington Admiralty pattern, 10 inches by 7 inches by 10 inches; two Worthington ballast pumps, vertical duplex, 10 inches by 12 inches by 10 inches; one salt-water deck service and fire pump, 6 inches by 4 inches by 6 inches, and one fresh-water pump, 3½ inches by 4 inches by 4 inches, the two latter being of Worthington's make. There is an auxiliary condenser with 700 square feet of cooling surface, the pump for this being 6 inches by 6 inches. In addition to the high-pressure feed pumps there is one Hancock injector, with a 2-inch suction and a 2-inch discharge for the main boilers.

The electrical equipment includes one 15-kilowatt, 115-volt, direct-connected General Electric Company's marine generating set. A steam heating system is installed throughout the living quarters.

The cargo is handled by the Spencer-Miller marine transfer system, the installation including ten Lidgerwood hoists, each operating a ¾-yard clam-shell bucket, capable of discharging 50 tons per hour per hatch. Therefore, the cargo can be discharged at the rate of over 300 tons per hour.

The deck machinery consists of a Hyde steam windlass, a Hyde steam capstan, located on the poop, and a steam steering gear. There are also two double-drum winches located on the poop.

The total bunker capacity is 700 tons. Provision is made for 2,000 tons of water ballast and 125 tons of fresh water and stores, making the total deadweight capacity 6,125 tons.

## Experiments with Oil Fuel Burners.

During the past year experiments were made by the Bureau of Steam Engineering, United States navy, with an installation for burning oil fuel on board the monitor *Cheyenne*. The system used was one in which the oil is atomized by compressed air after having first been passed through heaters.

In his annual report, Engineer-in-Chief H. I. Cone states that the results of the experiments were very satisfactory, and the installation has increased the ability of the vessel to maintain a constant steam pressure and to develop a high power for long priods without tiring out the personnel.

The Bureau has concluded, however, that this system is not the most desirable for use in naval vessels on account of the weight and space required for the necessary air compressors, and also on account of the desirability of having the heavier vessels so fitted that either oil or coal, or both fuels in combination, may be used, as desired, as coal can be obtained wherever a ship may go, while the ports at which oil fuel may be obtained are limited. With this latter consideration in view, the Bureau is fitting in larger vessels only such oil fuel systems as operate by mechanical atomization of the fuel under high temperatures, the necessary air for the combustion being supplied by the regular forced-draft blowers of the vessel.

## A Submarine Armored Cruiser of 4,500 Tons.

BY N. PORTUGALOF.

After the Russo-Japanese war there arose in the Russian fleet, principally among the younger members of the crews, a sense of the necessity for fundamental reforms in all the branches of the naval department in order to avoid further defeats. Russia has three separate seas washing shores which are of great importance to her, and since she has no intermediate bases, there is no immediate possibility of forming in these seas fleets exceeding in size and strength those of her neighbors. Recognizing this peculiarity of geographical situation, there exists in Russia a considerable party which is working to develop the various lines of naval power to meet it. The latest novelty in this direction is a project for a submarine cruiser of 4,500 tons, invented by the naval engineer B. Shuravleff, who formerly worked on the augmentation of the seagoing capacity of modern battleships, and succeeded in having his ideas applied on the new Russian ships which have recently been laid down.

His project for a submarine cruiser has for its object the building of a ship capable of acting in the Baltic Sea, as well as in the Pacific, in view of which it has—in comparison with other submarines—a very low hull (only 25 feet from keel to top of conning tower), with a displacement of 4,500 tons. This makes it possible for the cruiser in question to attack ships of the line even in the shallow waters of the Baltic. If we take into consideration the latter purpose the submarine has a tremendous sea-going capacity; *i. e.*, 18,000 miles, which is of immense importance for Russia, inasmuch as she has only one naval base in the Far East—Vladivostok—with the probable necessity for sending ships from the Baltic.

The speed of the cruiser makes it possible for it to act against large ships, as it is designed for a speed of 26 knots under water.

For defense against the smaller shells of the enemy, if for some reason the cruiser should not be able to dive in time, it has a 2-inch armored deck, with an incline of 3½ inches and an interior shell of ¾ inch, which permits of its diving even in case of injury to the fastenings of the armored deck.

The armament consists of thirty-six torpedo guns of recent construction, convenient for holding torpedos for a considerable time, and which have at the same time a wide range of fire. Besides torpedoes the cruiser also carries about 200 floating mines, which can be placed either under or on the water. For a secondary battery the cruiser has five 4.75-inch quick-firing guns, located in a revolving turret.

A special construction of the Kingston valves and tanks permits quick diving and gives the vessel a light balance.

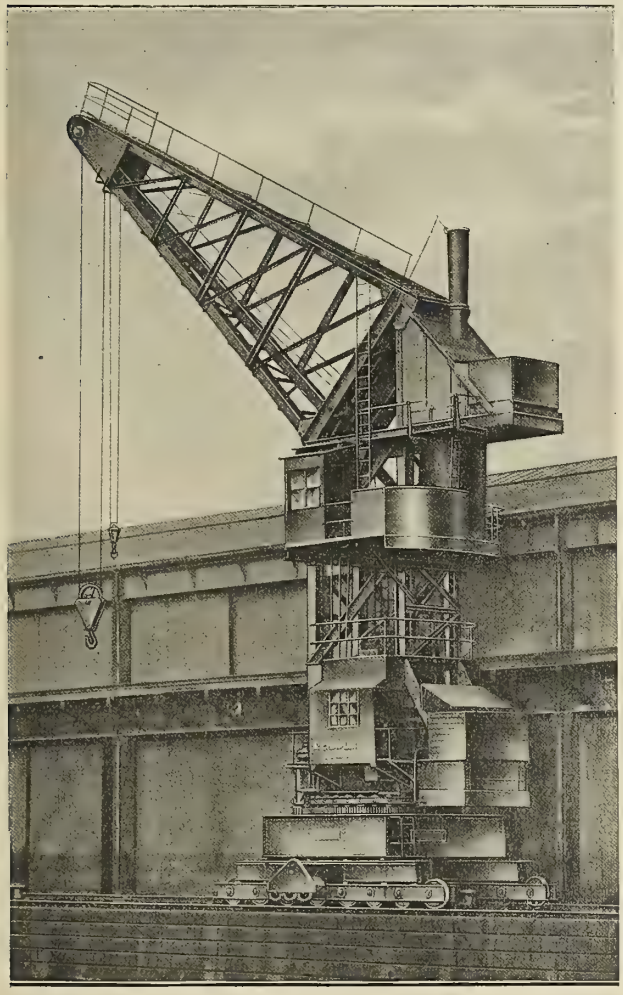
The naval engineer Shuravleff has designed three variations of this cruiser: One fitted exclusively with Diesel internal-combustion engines, which are being used more and more in the Russian fleet, and two with Curtis turbines and White-Forster boilers, the latter being well known in the English fleet, and new ones of the Russian inventor Tabulevitsch.

In the two latter variations of the cruiser there exists a special arrangement for the economic speed, which allows the cruiser the same sea-going capacity as it has with internal-combustion engines alone; *i. e.*, 18,000 miles.

Not only would such a submarine cruiser afford comparative safety against the enemy, but its comparatively large tonnage, allowing to be manned for a considerable time, thus removing one of the principal defects met with in submarines; *i. e.*, the impossibility of action when same are at a distance from their base of operation. This indicates the possibility of a submarine fleet which shall have all the properties of an ideal fleet.

### 25-Ton Steam Traveling Wharf Crane.

A 25-ton steam traveling wharf crane, which is of somewhat special construction, has recently been built by Alex. Chaplin & Company, of Govan, Glasgow, and has been erected at the Prince's Dock Berth of the Allan Line steamers, which is a very short distance from the company's works. The conditions as regards space were not particularly favorable, and this fact, together with the great height of the steamers now



SPECIAL TYPE OF WHARF CRANE.

in use in the American trade, made it necessary to adopt the special design shown. The crane is built to travel on rails of 11-foot gage, the carriage being mounted upon sixteen wheels, so as to distribute the weight of the crane, which with the load is more than 200 tons, over as large an area of the quay wall as possible. Upon this carriage the structure of the crane is built. The height of the tower, which has vertical sides, is 50 feet above the rails, which allows it to carry the jib clear of the sides of the highest vessels. At the top of this tower the jib is built outwards, to give a radius of 40 feet, and the height of the end of the jib is 75 feet above the rails.

On account of its great height and narrow base the stability had to be carefully considered. The machinery and the back-balance weights are placed immediately above the traveling carriage, and in this way the center of gravity of the crane is kept low. The driver's cabin is erected at the level of the spring of the jib, and from it all the motions are easily worked. At the rear and at the same level another strong platform is erected, which carries the boiler, water tank and coal bunker. In accordance with the practice which has been largely adopted by the builders, a separate set of engines is used for each motion.

**Contracts for the Argentine battleships,** proposals for which have been under consideration for some time, have been placed in the United States. Both ships are to be built from plans submitted by the Fore River Shipbuilding Company, Quincy, Mass. Only one of the ships will be built by the Fore River Company, however, since it is stipulated that not more than one vessel shall be built in the same yard. The other vessel will be built by the New York Shipbuilding Company, Camden, N. J., and the machinery for both will probably be built by the Fore River Shipbuilding Company.

**The Canadian naval programme,** as outlined in the Naval Defense Bill recently presented by Sir Wilfred Laurier, provides for four 4,800-ton protected cruisers, one 3,300-ton unarmored cruiser and six destroyers of the improved river type. According to the Premier's estimate the construction of these vessels in Great Britain would cost slightly more than $11,000,000, and about one-third more if built in Canada. It is the intention, if possible, to have the ships built in Canada, and if this is done the shipbuilding industry there will be placed on a desirable footing, since there is already a law under which the Government pays practically the whole of the annual interest charges on the capital invested in drydocks. Moreover, in addition to this it is expected that a bounty on shipbuilding will also be provided.

**From the returns compiled by "Lloyd's Register of Shipping,"** it appears that, including warships, there were 331 vessels of 913,374 gross tons under construction in the United Kingdom at the close of the quarter ending Dec. 31, 1909. Of this, 298 vessels, aggregating 908,373 gross tons, were steel steamers. The tonnage now under construction is about 135,000 tons more than that which was in hand at the end of the last quarter, and about 149,000 tons more than that building twelve months ago.

**The co-partnership arrangement** entered into a year ago between Sir Christopher Furness and his employees has proved successful and is to be continued. The experiment was originally undertaken for a year, and at the outset it was looked upon with doubt by the trades unions, where it was feared that the supposed beneficiaries would be committed to more work for the old rate of pay. While this doubt has not been entirely dispelled, the employees say that such excellent results have been obtained that they are anxious for a further trial. Even during the first year the returns which the workmen had received on their cash investments in the concern have amounted to a moderate increase in wages. Since the outlook for shipbuilding in Great Britain is now brighter than it has been in many years, the development of the plan will be watched with interest. It will be remembered that the workmen shareholders were to receive a 4 percent dividend on their share of the capital, while the ordinary shareholders were to be paid at the rate of 5 percent.

# VANADIUM STEEL CASTINGS are as strong as Carbon Steel Forgings.

The frames shown here are part of an order for six Mallet Compound Locomotives now building at the Schenectady works of the American Locomotive Company for the Delaware and Hudson Railroad. Each locomotive requires four frames, and each frame weighs about 8,000 pounds. The castings are 30′ 4″ long and the average tensile strength (on ten frames) is 80,975 pounds per square inch; the elastic limit is 45,024 pounds.

These locomotives will weigh, when completed, 414,000 pounds each.

The use of Vanadium in the most important parts of new locomotives results from the recognition of this element as "The Master Alloy" in the improvement of modern steel.

## AMERICAN VANADIUM COMPANY

318 FRICK BUILDING
PITTSBURGH, PA.

# VANADIUM

# VICTOR VANADIUM NON-CORROSIVE METAL

Is non-tarnishing and takes a very bright silver polish. All nickel-plated metal tarnishes, peels and wears off in a short time, and must be continually polished and re-plated. This metal always retains its bright lustre, and, being the genuine metal throughout, cannot peel.

Is non-susceptible to all vegetable and mineral acids, except nitric acid, and will not corrode or rust in salt water.

Is stronger than bronze or mild steel, having an elastic limit of 45,000 lbs., and a tensile strength of 66,000 lbs.

Extract from New York newspaper at the time of the burning of the vessel *General Slocum*, several years ago, when the sacrifice of hundreds of lives caused a general demand for better fire-appliances on salt water vessels:

"Many familiar with fire apparatus have said that the hose used on the *Slocum* would not withstand the slightest pressure, but there is no hose manufactured that cannot stand a pressure of at least one hundred pounds, and the whole point is lost sight of in an argument along this line. The fact is, that whether the hose cost sixteen cents per foot, or one dollar and fifty cents, it is the corrosion that prevents it being serviceable on the occasion when it is desperately needed. The Valves and the standpipes are sometimes of brass, oftener of brass and iron, which after a few months in service on the boats become corroded from the effects of the salt water, which causes rust, and the corrosion around the couplings rots and weakens the fabric so that if the valve is in condition to let on the water, as evidence has been given to show that it was, when the water is turned on the hose is forced from the couplings and becomes useless.

"The way to obviate the possibility of accidents to such fire appliances in the future, is to see to it that valves and couplings are made of a non-corrosive metal, such for instance as the Victor Non-Corrosive Metal, which has been on the market for some time, and has been adopted and in use by the United States Government on such torpedo boats as the *Fulton* and the *O'Brien*, and is called for by the New York Fire Department in its specifications for Fire Hose,who are ever alert to adopt practical benefits to its service.

"It is not strange that the managers of steamboats, and even fire experts and members of the Fire Department, are not familiar with this metal, as it is comparatively of recent production, but there is no question of the fact that its use on salt water craft generally would preclude the possibility of another such a failure of the the fire appliance to work, as occurred on the *Slocum*."

## VANADIUM METALS COMPANY

**Frick Building, Pittsburgh, Pa., U. S. A.**

# PRACTICAL EXPERIENCES OF MARINE ENGINEERS.*

## Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

### A Leaky Feed Heater.

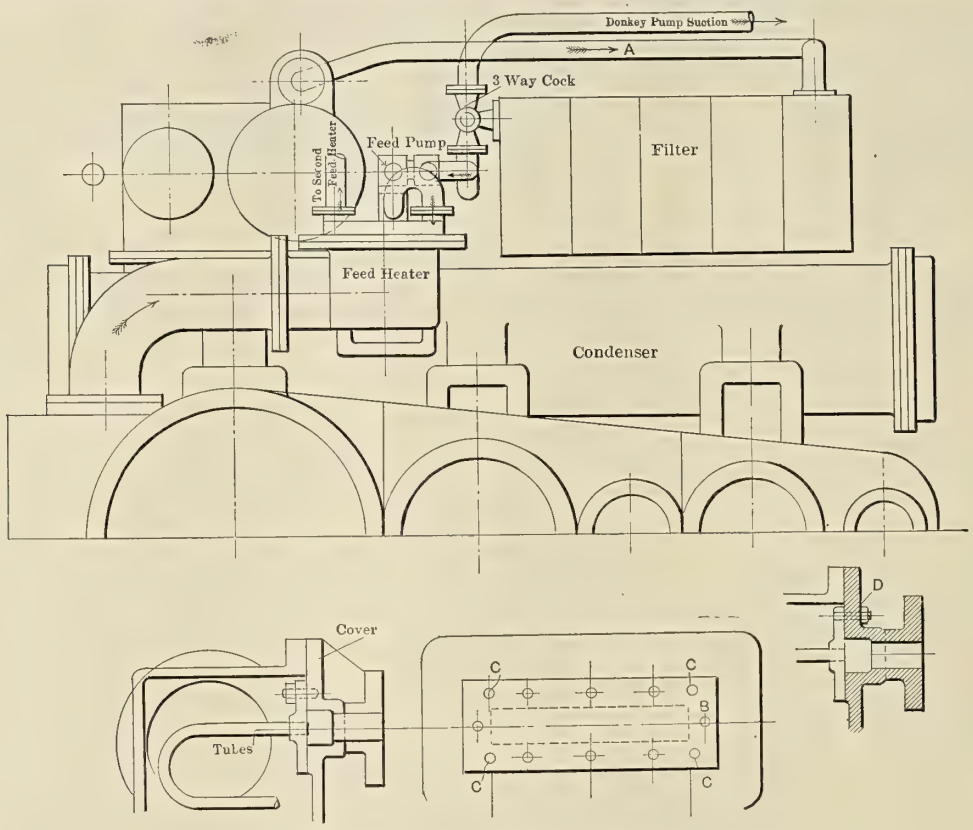
The following incident occurred on a trial trip of the tug *C*————————. At the back of the engine a feed heater was placed between the low-pressure cylinder and the condenser; the feed water was forced by the feed pump through copper tubes, attached to two tube plates, which were bolted to the cover of the feed heater. The tubes in the feed heater were exposed to the exhaust steam and thereby heated. To get the feed water into the boiler at very high temperature, it was further heated in a second feed heater, into which steam from the intermediate pressure receiver was admitted. The water from the hot well was led into an oil filter, from which it was taken by the feed pump.

On the trial trip, some hours after the starting of the engine, it was seen that the water level in the boiler was falling, and that at the same time the pipe *A* gave much more water than at the beginning of the trial. The feed pump proved to be in good working condition, and it was then understood what the trouble was.

The packing material between the tube plates and the cover of the feed heater was too thick and had given way, so that the feed pump did not pump the water into the boiler, but forced it back into the condenser. This water was delivered again by the air pump into the filter, so that the pipe *A* gave too much water.

On stopping the engine the water in the feed pipe was all forced into the condenser, and on opening an air cock inserted on the air vessel of the feed pump the noise of the inflowing air was heard, which proved that the suggestion was true.

The engine was started again, and the feed water from the three-way cock pumped into the boiler by the donkey pump. After a half hour, in which the mishap was thoroughly discussed, the level in the gage glass was again examined, but the water was no longer visible in the glass.




LOCATION OF FEED HEATER AND DETAILS OF CONSTRUCTION.

The first thing was to draw the fires and then to hunt for the cause. It was soon found. The donkey pump forced the water into a valve chest, in which it could be led to the boiler, overboard and to the feed tanks. Between the overboard valve and its seat a small piece of stone had become lodged, so that the valve was not closed and the water was pumped overboard. The spindle was turned back and, on shutting, the valve was now closed very well, and the feed water pumped into the boiler, in the gage glass of which the level was soon visible again. Afterwards the boiler was inspected, but nothing out of the way was discovered.

When the cover of the feed heater was removed, the packing showed itself to have given way at *B*, where the pitch of the studs was rather wide. The studs *C* were added and the tube plates packed with very thin packing material. The heater has given no further trouble, although it would be better to put the studs in the tube plates, as indicated at *D*,

* We pay for these articles.

and have the nuts placed on the outside. Then it would be possible to tighten up the nuts after the whole apparatus had been warmed through. D. Kooijman.

### Indicator Diagrams.

In recent issues of International Marine Engineering much has been written about indicators and indicator diagrams, therefore the writer thinks that the following will be found interesting.

From the triple-expansion engine of the tug *R*, indicator diagrams were taken on the trial trip, and the first high-pressure diagram is given in Fig. 1. This shows that the work exerted on the top side of the piston is much more than on the bottom side, and the cut-off on the forward stroke is much later than on the return stroke. Since, therefore, the compression at the top side was larger than at the bottom side,

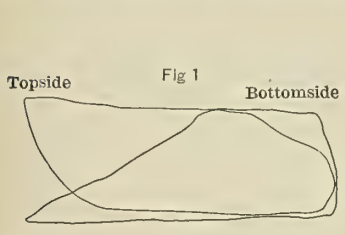


Fig 1

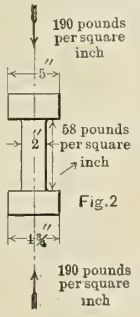


Fig.2

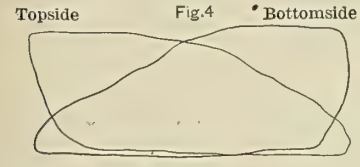


Fig.4

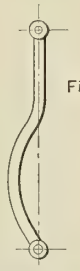


Fig.3

it was understood that the valve had been set too low. But this seemed impossible, as before the valve chest cover was put on, the cut-off, compression and lead were all examined and had been found to be correct.

As seen from Fig. 2, the diameter of the upper piston of the high-pressure valve was 5 inches, the diameter of the lower one 4¾ inches, in order to make it possible to lift the whole valve with the valve stem without taking off the bottom valve chest cover. The boiler pressure being 190 pounds per square inch, and the steam pressure in the second receiver 58 pounds per square inch, the action of the steam in the line of the valve rod is as follows:

Downwards:

$\frac{1}{4}\ \pi\ (5)^2\ 190 + \frac{1}{4}\ \pi\ [(4\frac{3}{4})^2 - (2)^2]\ 58 = 478$ pounds.

Upwards:

$\frac{1}{4}\ \pi\ (4\frac{3}{4})^2\ 190 + \frac{1}{4}\ \pi\ [(5)^2 - (2)^2]\ 58 = 420$ pounds.

Resultant force acting downwards, 58 pounds.

The weight of the valve plus valve rods being 104 pounds, the resistance to be overcome when the valve is moving upwards is friction of valve plus 58 plus 104 pounds. When moving downwards, friction of valve minus (58 + 104) pounds, the difference being 2 (58 + 104) pounds = 324 pounds.

The valve was provided with solid packing rings, the friction of which was very much due to the fact that they fitted too closely in the valve bushes. The reversing gear was of the Bremme type, and the cast steel eccentric rod (Fig. 3) had been bent by the great forces acting on it. Whn the valve was moving upwards, the deflexion was more than when downwards, the resistance being larger in the first case. The result was that the eccentric rod became ¼ inch shorter, so that the valve showed itself to have been set too low. The cover was taken off, the valve set ¼ inch higher, and more oil was given to the engine. The new diagram (Fig. 4) showed that the difficulty had been overcome. No further deflection of the eccentric rod was indicated by the diagrams.

Probably the rod had been bent during the first revolutions of the engine after starting the first time, as no oil could be given to the rubbing surfaces, and much core sand, which was left in the steam ports, was blown in, which augmented the friction. D. K.

### Complete Breakdown of a Low-Pressure Engine and Repairs to Same.

The following disastrous accident occurred aboard the steamship *Warfield* several years ago in mid-ocean, en route to Auckland from San Francisco. The ship had encountered extremely bad weather, which lasted about ten days, and the engineers on watch could never at any time leave the throttle, the pitching of the vessel was so great. At times the entire propeller would be exposed. Nevertheless, aside from the disagreeable conditions in general everything apparently was working well.

However, on the last day of the storm, with the second engineer on watch, the independent feed pump suddenly began to slam, owing to the plunger packing being worn out, consequently the engineer had to leave the throttle a minute in order to start the donkey feed pump. He had pulled the throttle down enough to check the speed of the engine considerably, but while he was away from the throttle a terrific pitch of the vessel brought the propeller out of the sea. The engine raced at about twice its usual full speed revolutions, and before the engineer could get back to the throttle one of the low-pressure crank-pin bolts sheared off at a point just below the nut and dropped out into the pit. This immediately opened the brasses on that side, and on the next revolution the other bolt snapped, freeing the connecting rod from the pin. As the valve was then in a position admitting steam to the bottom of the piston, it caused it to shoot up against the cylinder head, splitting it in two; also ripping several studs out of the cylinder. The next instant, before the engineer could reach the throttle, the loose engine received steam on the top side and made a violent down stroke. Here is where the greatest damage was done. The foot of the connecting rod got in the path of the turning crank and was jammed hard against the column, breaking and cracking large pieces out of it until it reached the base of the column. Here it stopped, but the crank and piston, still with power behind them, buckled the entire cross-head between the guides, bending the piston rod where it enters the cross-head block. This cracked both guides and columns, and the foot of the connecting rod carried away a large part of the column base, getting bent itself by the crank. This damage was all done in about two revolutions, so quick, in fact, that the engineer did not have time to stop the engine in order to prevent it.

It was impossible to consider drifting until help could arrive, so the debris was cleared away and temporary repairs attempted, so the ship could proceed, using the high-pressure engine. Without the low-pressure engine, however, nothing could be done, as the air and bilge pumps were worked from the low-pressure cross-head and beams. The ship was still pitching, which greatly added to the danger of a general collapse of the disabled engine.

Notwithstanding these dangerous conditions, repairs were started. The jacking engine was engaged to the turning gear, preventing the action of the sea from partly turning the

shaft. The removal of the connecting rod was next attempted. This was jammed so hard in the cross-head and column base that the greatest difficulty was met with in its removal; the work took about fifteen hours.

The task of freeing the shoes from their buried position in the guides, and on a bent piston rod with bent cross-head bolts, was still greater, considering the few appliances that were on hand. However, after almost twenty hours' work, it was also cleared.

The cracked cylinder cover was next lifted and lashed to the other cylinders, with the intention of lifting the piston and removing the rod. This was accomplished by a 5-ton triplex block hung from the overhead track. The nut was already slack, as the piston was driven over the taper about ¼ inch, so no trouble was met with here. However, when the removal of the piston was attempted, it was found that it was forced on the rod so hard that ordinary means of taking it off would be of no value. It could not be drawn out with the rod, as the bent cross-head end prevented it, so a fire was built on the piston, with the expectation that it would expand enough, allowing the rod to be hammered out and taken from the bottom end of the cylinder. The seas had abated somewhat by this time, permitting greater progress, and the shoring of the engine was commenced. Heavy timbers were taken from the cargo and brought into good service. From the side bunkers and after bulkhead these timbers were placed against the cylinder. Similar timbers shored up from the bed, etc., also from the overhead beams. All this shoring held the cylinder and columns in a very secure position.

Next, the work of making a cross-head was started. This was easy enough, as spare shoes were aboard and all that was needed was to bolt them on the cross-head block, although side guides had to be made. Four pieces of flat iron about 3 inches wide and 1 inch thick were found and then bolted on the sides of the shoes, preventing the cross-head from any possible side-play.

The connecting rod had not received serious enough bending to necessitate straightening, and it was used in its bent form. Both cross-head and pin brasses were still in fair condition, suitable for use at least. Spare bolts were aboard and in due time the rod was connected up with the cross-head and crankpin. The low-pressure valve was removed from its stem, and the admission ports plugged tight with hard wood.

When everything was in readiness the engine was turned over by the jacking gear; everything apparently moved all right. Steam was raised to about one-half full pressure and admitted to the high-pressure engine, which worked all right, except for a groan at every revolution, owing to the strained shaft being partly out of line with the engine. This caused the shaft journals to heat considerably. After slacking all the journal nuts, however, they worked better.

After running under reduced speed on the second day, the boilers showed a salt saturation, consequently we had to stop again and examine the condenser. On opening same several tubes were found leaking excessively. In a few hours we were under way again, with better conditions.

For five weeks the ship steamed with "one leg," and when port was reached the crude repairs were still intact. However, the entire engine had to be dismantled and a new one installed, although great credit was given for the repairs made and the durability of same in lasting five weeks without any signs of giving out. F. J. W.

## Replacing the Propellers of a Twin-Screw Steamship without Docking the Vessel.

While crossing the Pacific Ocean from Japan to the United States recently, the British steamer *Bellerophon* of the Blue Funnel Line lost two blades from her port propeller. Two spare propellers were carried on board, but, as they were of different pitch from those in use, it was necessary to unship both the latter and adjust the two spare ones. Arrangements were made to place the vessel in the Puget Sound navy drydock, but before doing so an attempt was made by the chief engineer and his assistants to carry out the work without docking the vessel.

The *Bellerophon* is a twin-screw steel steamer of 5,727 gross tons, built in 1905 by Workman, Clark & Co., Ltd., Belfast, Ireland. She is propelled by two triple-expansion engines, having cylinders 23, 38½ and 65 inches in diameter by 48-inch stroke. To carry out the repairs she was put down by the head by filling her forepeak and No. 1 hold full to the main deck, and No. 2 hold to a depth of 11 feet. This brought the stern out of the water, with both propellers clear, when scows were brought alongside and the work of replacing the propellers carried out. After the new propellers were in place the water in the forward part of the vessel was pumped out and she soon came to an even keel. The entire job was carried out at slight expense by members of the crew within five days.

## Raising a Sunken Steamer.

The steamer *Milan* of about 850 tons register, ladened with 2,000 tons of coal, and about to proceed to sea was passing through the lock pit at the Alexandria dock, Hull, when she collided with the quay wall. The starboard bow of the vessel struck the wall, not with a hard blow, but with one which would easily have been warded off by a fender. As it happened, however, the anchor became wedged against the quay wall and pierced the plates below the waterline. The captain

VIEW OF THE SUNKEN STEAMER.

decided to put back into dock and wait until daylight in order to ascertain the extent of the damage, as it was then about 3 a. m., and not being aware that anything really serious had occurred, the crew turned in, but about 5 o'clock it was discovered that the vessel was slowly sinking. The pumps were set in motion, but they were found to be insufficient to cope with the inflow of water. The ship settled down by the stern and the crew were forced to abandon her. Finally, at about 7:30, she sank until only the masts, funnel and bridge were visible. Some of the hatches were burst off as she settled down.

The vessel lay in about 29 feet of water and had to be relieved of her cargo before she could be raised. Divers

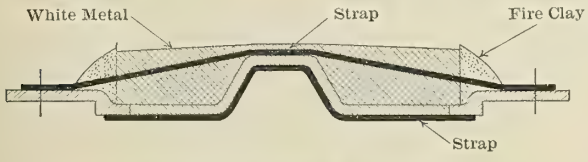
were set to work for some days previous to the attempt to raise the vessel, patching up the hole, which had caused her to founder, and plugging up all other inlets. The sides of the forward deck were built up with timber, canvassed and battened, and the hatches and skylights were also covered securely to facilitate the work of raising the vessel.

A salvage steamer was placed alongside to supply the necessary steam for working the pumps, and after the level of water in the dock had been lowered about 4 feet, pumping was commenced. Four pumps were employed, two amidships to deal with the water in the engine room, and one forward and one aft. The forward part of the vessel was pumped out first, and afterwards the pumps at the after end were started. The vessel rose rapidly and within a few hours was again afloat. She was then placed in drydock for repairs.

J. F.

### Repairing the Cover of a Ballast Donkey Pump.

An interesting experience, which occurred on board a ship at a time when it was due to go to sea, may be of interest to your readers as illustrating the kind of temporary repair which is necessary in the event of an unforeseen accident. The particular instance occurred in connection with the pump cover of a ballast donkey engine. There happened to be a flaw in the piston rod, close to the neck of the cross-head, and as the pump was kept working for some days without cessation, even day or night, the strain was too much on the rod, and it snapped off short. The result was that the piston




DETAILS OF REPAIRS TO COVER OF A BALLAST PUMP.

traveled up further than its stroke, and came into violent contact with the cover. The blow was so struck that it broke the cover round the inside of the flange, the cover coming away in two pieces, leaving the flange intact. Fortunately, there was on board a piece of iron that was suitable for making a new rod, so that this part of the difficulty was overcome fairly speedily. As, however, the original cover had been raised in the center, or dished out, in order to allow the end of the rod to work up into it, it was impossible, without a great deal of trouble, to make a new cover out of a piece of plate, which would have been the usual course to pursue. It was also impossible to get another complete pump cover cast in the time available before the time of departure of the ship, so that a much more risky and temporary repair had to be resorted to.

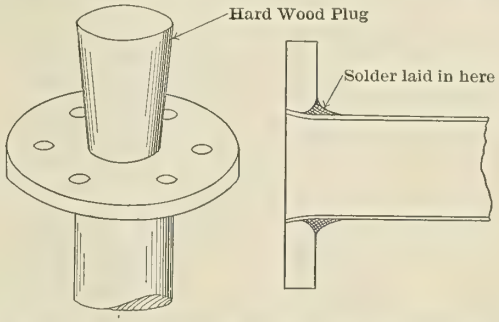
With the aid of some red putty and cement, the pieces of the cover were stuck together so that they were secured in their proper places. A piece of flat iron, 1¼ inches wide by ⅛ inch thick, was cut and bent to take in the broken pieces, and it was riveted on to the under side of the cover. Another similar piece was made to fit over the outside of the cover, and to pass over two of the cover studs. When the cover was screwed down these straps drew the broken parts together tightly, and after the cover had been put into place and jointed down, a strip of tin was placed around the outside of the broken parts, in order to form a kind of tray, and inside this fireclay was built up so as to form a solid mass. The whole repair was then run up solid with white metal, the general appearance of the repair being as shown in the sketch. Although this repair appears somewhat unorthodox, it was found in operation to be quite satisfactory. The pump was running nearly every day for three months after the date of repair and before a new cover could be obtained, and not the slightest leak of steam was apparent.

F. B. FOSTER.

### Fractured Lead Pipes.

It is rather astonishing that the usual sea-going engineer knows very little about plumbing. The usual method which such a man employs, in order to repair a fractured lead pipe, is to take a piece of canvas, smear it over with white lead, and bind around it with marline, until such time as the ship shall arrive home. When the boat gets back into port, the plumber who is called in to effect a permanent repair has every reason to indulge in a quiet smile when he takes his knife to cut off a fathom or two of marline and a yard of canvas in strips in order to find a ¼-inch hole.

That such a subject may be mentioned with advantage is shown by the fact that it is no unusual thing for engineers to take the prong of a file and drive this into the bilge suction




pipe in order to see whether the pump is drawing. If such a thing has to be done it is just as well to use a small gimlet or pricker, as this makes a clean, round hole. It does not bulge the pipe in and the hole can be stopped up again with a small wood block. Where, however, a hole has been made, either accidentally or purposely, it is as well that engineers should know how simple it is to do a little piece of plumbing. It does not make much difference where the pipe is broken, whether in the neck of the flange or in the length of the pipe, or even if the flange is off altogether. To take the worst example, suppose that the flange of a lead pipe has come away altogether. The hole in the flange should be rasped out in order to admit the pipe, and the latter should be allowed to come flush with the flange. When this is the case, a tapered hardwood plug should be driven into the pipe, in order to expand the same into the flange, as shown in the first sketch. It is then necessary to scrape the parts thoroughly clean ready for the solder.

In order to make a kind of solder suitable for this class of work, the best mixture is to take one part of tin to one and a half parts of lead. The block tin makes the strongest possible job, but if there is none of this on board common solder will answer the purpose, using tallow or resin as a flux. The solder should be melted in a ladle and poured around the neck of the flange, as shown in the second illustration, finishing off the run solder with the smooth side of a piece of corduroy lamp wick. The lead flange and the pipe end should, of course, be slightly heated before soldering, in order to get good running of the solder, and by rubbing a mixture of lampblack and size on the parts which it is not required to solder, it will be found that any of the metal which has escaped on to such surfaces can be very easily rubbed off. It will be found that the directions given above will suit any repair to lead pipes which is likely to be found on board a vessel at sea.

FRANK ROBERTSON.

### Trouble with the Pump Links.

On overhauling the engines of a tramp steamer after the pum links had been adjusted and nicely swung, the boat had a run of twenty-four hours to the next port, and it was then found that the links rattled most violently. When the ship had been taken into port the links were taken down and trammeled. It was then found that the feed-pump end was a good bit down and needed lining up. This involved rather a troublesome job, in order to get the links hauled up out of the brasses. The floor of the bunker came so close down upon the links that there was not sufficient room to get a pair of blocks up into position, so that it became necessary to cut a hole in the bunker floor. When this was done a shackle was put through the hole and provided with a bar, which spanned the hole and rested on the bunker floor, thus taking the weight of the shackle and everything which it had to support. The links were then placed on the top stroke, and in this position were made fast with slings to the roof. Then the cover and the top brasses were taken out, and the engine was turned on to the top center. This lifted the links out of their bearings, and it then became possible to get the bottom brasses out. A liner of the required thickness was then put under the brasses, and after these had been put back and the bearings adjusted, it was found that the knock had been entirely done away with.

### Opening Out an Injection Valve with the Ship Afloat.

It is not often that the task is attempted of opening out an injection valve on board a vessel while the ship is floating freely in the water, as it is rather a risky kind of job, and most engineers are not altogether anxious to try such an expedient. It is, of course, preferable that when such work is to be done the boat should be dry-docked. But it occasionally happens that trouble occurs with the valve in some foreign port where there is no dock and no suitable position where the vessel can be beached.

In one instance the trouble which arose was that a pin was broken on the main injection valve spindle. This valve was cast with a double eye, and the spindle was fitted into this and held by the pin. When the pin was broken the valve then became a non-return valve. It would have been impossible to proceed upon a long voyage in this condition, as in a seaway the jolting up and down of the valve would very soon have caused trouble. In every probability it would first have broken away the end of the spindle, thereby increasing the injection of water, and in time it would most likely have meant the loss of the valve altogether.

In order to repair this defect the work was carried out in the following manner: It was known that the size of the connecting pin lost was ⅜ inch in diameter, and a second pin to this dimension was therefore made ready. In addition, everything else which could be foreseen was prepared, such, as for example, a new joint for the cover, etc. After this the pipe joint leading to the condenser was broken in order to allow the water to run into the bilges. A piece of strong canvas about 10 feet square had been obtained, and a line was fixed to each corner; the spot over the side was marked where the sea inlet to the injection was, and two men were told off into a boat, with orders to sink the canvas down to about the position where the valve was. At the same time two engineers were placed at the valve in the engine room, leaving a man on deck to pass the word from the boat to the engine room, or *vice versa.*

When all preparations were made and everything was ready the valve was quickly opened full out, and the water rushed through the sea inlet into the injection pipe and through the broken joint into the bilges, until the pressure of the water on the outside forced the canvas against the inlet grating. As soon as this had occurred the engineers in the engine room knew of the fact because, with the exception of a slight trickle, the inrush of water was stopped. A few minutes were then allowed to see if the canvas would hold tight; this was fortunately found to be the case, and as soon as this was ascertained the valve cover was lifted as quickly as possible, the new pin fitted and the cover replaced.

This repair may be regarded as a somewhat daring operation and, of course, it can only be conducted in perfectly calm weather and when the ship is light, otherwise there would be danger of the surge of water outside lifting the canvas flap, or if the boat is deep down in the water the head of water at the grating would probably pierce the canvas shield. If, however, this is done with care the procedure is quite safe and may save a heavy expense in dry-docking the vessel.

Economy.

### A Hint on Steering Gear.

Except on the largest boats the steering gear is very often neglected at sea, inasmuch as the engineers on board the vessel appear to think that the function of keeping it in proper working order is out of their department. They prefer to trust to the makers of the machine to send their own fitters to overhaul the gear on arrival at port should any defects occur.

This is, of course, a most unwise policy, and it is difficult to account for it unless it is owing to the fact that most of the steering engines are built in a very compact form and the parts are therefore difficult to get at. Unless specially accustomed to that class of work the average sea-going engineer would rather leave the matter alone so far as possible.

It will, of course, be understood that the valves used, in order to give steam to the pistons, are themselves piston valves. About the most puzzling job on the steering-gear engine is to find the leads of these valves, inasmuch as the cylinder is too small to examine, either by observation or touch, in order to measure the steam or exhaust ports. The rest of the overhaul of the steering gear is fairly ordinary; the following is therefore a useful hint as to the best way of finding the leads of these valves: Take a strip of paper, and push this into the cylinder so that it passes right through to the other end; then press with the finger or rub along the paper with a blunt stick and withdraw the paper. On properly measuring the marks left on the paper the size and position of these ports will be obtained. This, although a very simple hint, will probably save considerable time and labor.

### Oil Ways in Small Bearings.

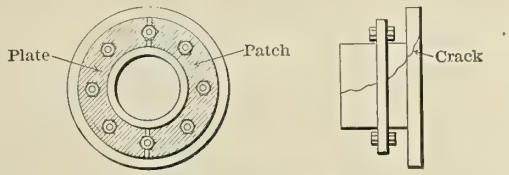
Although at the present time marine engine builders have, as a general rule, crystalized the experience of sea-going requirements into definite design of a high-class order, there yet occur cases in which small improvements are found to be necessary by the engineers on board a ship when they take the vessel to sea. One of the most common causes of trouble in a boat which is just out for its first run, is that the oilways in the small bearings are sometimes insufficient for their purpose. When the job is turned out from the shops, oilways are cut into the top half of the bearings quite corectly, but very often it is found that there are none at all in the bottom half. In such a case, the lower portion of a pin, which does not completely revolve, but simply oscillates to and fro through a certain arc, is found to be running quite dry, inasmuch as too much trust has been placed in the possibility of the oil working down from the top half to the lower bearing surface. In some instances the bearing brass and pin are very badly

scored, more especially in the case of the top end pins of connecting rods. It is not advisable in such cases to thin the lubricating oil sufficiently to penetrate down to the bottom brass, as it then becomes too thin to be of any great service in lubricating, and it is better to take the bottom brass out and cut an oil channel down each side of the brass nearly to the middle. In this way the oil is carried round to the bottom half oilways as the pin moves in its half circle, and it is astonishing to note the difference that is made in the life and running of both the pin and the brass. This point is worth the attention of all engineers in charge of a ship which they are taking out for the first time, as it will save a lot of trouble if a preliminary overhaul of the small bearings is made before any chance for trouble has been given. Experience.

## A Broken Stern Gland.

It sometimes happens that in spite of every care and precaution which is taken in effecting renewals and repairs the attempt to get over minor trouble leads to a much more serious complication, and when this happens a considerable amount of resource is necessary in order to put matters straight again. An example of this may be given: In a certain twin-screw ship it was required to put a turn of packing in the starboard stern gland while the vessel was afloat, as it was found that the gland was leaking rather badly. In order to accomplish this a diver was sent down outside the vessel, and was successful in stemming the outer end of the tail shaft before the gland was slacked back.

When this was accomplished two turns of packing were drawn out of the gland, and an attempt was made to get three turns of new packing in. This was, however, too much for




REPAIRS TO A STERN GLAND.

the gland, as while tightening it up too much strain was put on the nut, and the gland broke in two pieces. The illustrations show the nature of the fracture, from which it will be seen the crack went right through the middle of the gland. It was necessary to repair this in place, as there was not sufficient time to enable the engineers to get a new gland made before the ship sailed.

In order to accomplish this a narrow band was put round the barrel of the gland, as shown in the second sketch, in order to draw the broken parts of the gland tightly together. The next step taken was to get two pieces of ¾-inch plate to cover the flange of the gland, and these plates were drilled so as to go over the studs. In this way the gland was secured both on the flange and on the barrel, and in this position the gland was screwed up and made tight. So successful was the repair that the ship was taken to the Cape and back to Southampton before she was docked in order to have a new gland put in.

## Bending Pipes at Sea.

It is not a very easy matter to bend pipes at any time without proper appliances, and sea-going engineers as a rule have not a very clear notion as to how to accomplish this work if they are faced with trouble of such a character. It is not included in their work on shore, as it is usually left for plumbers or small steam fitters. A knowledge of a few ways of doing this work is therefore very useful; as, for example, in cases where it becomes necessary to fit up a speaking tube, say, between the deck and the engine room or from the chief's berth to the engine room. A speaking tube of this nature may be made from old condenser tubes, and this becomes quite easy if the engineers know how to bend such tubes to any required shape.

This is done by filling up the tube with sand and blocking up the ends. If no sand is available, resin, which is usually carried on board a vessel, will do instead. When the pipe is filled it can be bent to any shape, and if it is not too thick in diameter it may be bent cold. Iron pipes above 1 inch in diameter may be bent without sand if care is taken to have the part to be bent maintained at a good red heat. It is hardly necessary to say that if the pipe is not filled it will usually go flat at the bend and have a very bad appearance, and in the case of condenser tubes they will break or kink.

The illustrations show the way the piping becomes distorted if it is bent without an internal filling. In some cases a very

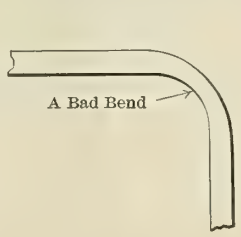



FIG. 1.

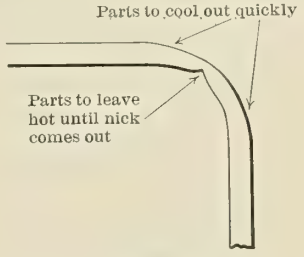



FIG. 2.

nasty nick is obtained, as shown in the second illustration. If this should occur in an iron pipe, a method of taking this out again if the pipe is not fractured is as follows: The whole bend should first be heated to a good, red heat, and this cooled down all over except immediately at the nick. The part which is left hot will then come out to its original position. The second sketch shows the parts which have to be cooled and left heated, respectively. J. H. Smith.

## Hot Thrust Bearings.

In a new ship it was found that the thrust was running hot, and a considerable amount of attention had to be paid to it. It was attributed in the first instance to the way in which the cargo was distributed throughout the ship, as it was thought that the load had disturbed the line of shafting running from the engine to the propeller. In order to minimize the difficulty water was run on to the thrust shoes in order to keep them as cool as possible, and in addition the trough under the shaft was kept full of oil, so that the revolving collars dipped into the oil, and so lubricated themselves. In spite of all this, however, the thrust still ran hot, and this presented a problem which was not satisfactorily solved until after twelve months' continuous trial. It was at last decided, however, to cut on each of the eight collars four oilways on the headway side. These oilways did not run right down to the shaft, but very near to it, as shown in the sketch, so that they formed four radial pockets for oil. When the collar came round each time with the shaft these pockets dipped into the oil and water in the trough and carried some of the mixture round with them. It enabled the bearing surface of the thrust to be lubricated practically throughout its whole width, instead of, as before, at the circumference and such points as those to which the oil penetrated. This increased lubrication device effectively stopped the heating up of the thrust altogether.

George Halsey.

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## Turbine Propulsion.

Recent developments in turbine propulsion, as reviewed elsewhere in this issue, indicate a continual search for some means whereby the usefulness of the marine steam turbine can be extended to all classes of vessels and all conditions of service. At present the inherent advantages of the turbine can be realized in practice only to a limited extent, and, notwithstanding the widespread popularity of this type of engine, the enormous installations that have been made, and the spectacular speeds that have resulted, its field is still restricted to naval vessels and certain special types of merchant ships.

The pre-eminence of the turbine for naval work is undisputed. All recent warships in the British navy and many in other navies are so engined, and the magnitude of this work can only be realized when it is considered that there are now either actually built or contracted for 2,000,000 brake-horsepower of Parsons turbines for the British navy alone. The requirements which are peculiar to warship machinery, such as the minimum limitations of weight and space; the necessity for keeping the propelling machinery well protected; the minute sub-division of the hull in the machinery space, and the demands on the engines for large and frequent variations of speed, and for economical working at a low or cruising speed as well as at full speed, are more satisfactorily met by turbine machinery than by any other type. Not only this, but the smoothness of working, the absence of confusion in the engine room, the ease of handling and minimum amount of repairs, all have served to place the turbine high in the regard of the marine engineer; and we have yet to come across the man who has had charge of turbine machinery who is dissatisfied or prefers to go back to the reciprocating type.

Of course, turbines would never be justified if their economy did not compare favorably with that of reciprocating engines. In this connection it may be stated that the average steam consumption of the three battleships of the *Bellerophon* class is said to be 13.01 pounds per brake-horsepower per hour for the turbines only, with an average steam pressure of 147 pounds per square inch gage at the high-pressure turbine. In the *Indomitable* class of battle-cruisers, where the turbines are of much larger size and run at a slower rate of revolution than those of the battleships previously mentioned, the average consumption of steam at full power for the turbines only is said to be 12.03 pounds per brake-horsepower per hour, with an average steam pressure of 123 pounds per square inch gage at the high-pressure turbine. Results such as these certainly justify the turbine from the point of view of economy.

Successful as the turbine has proved in meeting the requirements for warships, it has made but little impression on the great bulk of merchant shipping. The reasons for this are well known and need not be enumerated here. This is the problem which is now engaging the attention of marine engineers to the exclusion of nearly everything else, and the time is probably not far distant when it will be possible to drive the low-speed, single-screw tramp by a turbine engine with satisfactory economy. All schemes proposed to effect this are still in the experimental stage, and, so far, no practical results have been obtained to conclusively prove or disprove their value.

Of these proposals, that providing for electric transmission promises a saving in fuel and a reduction in the machinery weights and space; but the initial cost is high, and the system involves undesirable complication. A spur gear reducing mechanism is being given a practical tryout, and good results are promised. Similar expectations are entertained for an hydraulic reducing gear, consisting of a high-speed primary water turbine driving a slow-speed secondary water turbine. In view of this activity in the experimental field it is impossible to doubt that a speedy solution of this important problem will be forthcoming.

### Experiments with Navigable Models.

Professor C. H. Peabody announces that the Department of Naval Architecture of the Massachusetts Institute of Technology is about to undertake important investigations concerning the propulsion of ships by aid of a navigable model about 40 feet long. This method of research has already been used in Great Britain in connection with the designs of the *Lusitania, Mauretania* and *Otaki,* where the proposed designs were carried out on a small, inexpensive scale and tested under approximately the actual conditions of service. The immediate problem which has been chosen for investigation at the Institute is the obscure one of the added resistance due to the action of the propeller working in the wake of the vessel.

In order to take advantage of a successful series of progressive speed trials which were made several years ago by Professor Peabody, the experimental boat will be a one-fifth scale model of the United States steamship *Manning.* Having at hand the data obtained in the former progressive speed trials of this vessel, the results obtained with the model will furnish a certain basis for determining from model experiments what may be expected of full-size ships. The propulsive machinery of the model will consist of a gasoline electric generating set and a motor geared to the propeller shaft. This combination is convenient for experimental work, since the conditions can be controlled over a wide range and the measurements of power be easily made.

This method of research opens up a wide field of possibilities and leads us to expect that many of the abstract problems in connection with resistance and propulsion which have hitherto been obscure, as well as many of the concrete problems arising in the design of new vessels, will by this means meet with a ready solution.

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### Naval Matters.

Comparisons of the naval strength of the nations are seldom satisfactory, for the reason that so many factors can be included or omitted in the estimate according to the judgment of the statistician. A comparison by tonnage, however, is useful not because it necessarily gives the fighting strength of the navies, but because it represents the nation's naval resources. At the present time, the standing of the naval powers, according to the figures given by the Secretary of the Navy in his annual report, is as follows: First, Great Britain, 1,758,350 tons; second, United States, 682,785 tons; third, Germany, 609,700 tons; fourth, France, 602,920 tons; fifth, Japan, 400,368 tons. If the vessels now under construction were completed, the only change in the relative order of standing would be that Germany would take second place and the United States third, with France a close fourth.

In new naval construction speed is beginning to play a very important part. It was only a few years ago that sixteen or eighteen knots was considered a sufficient speed for a battleship. To-day battleships are not designed for less than twenty knots' speed and the advent of the large armored cruiser or, as it is sometimes termed, the battle cruiser with a speed of twenty-six or twenty-eight knots has made the matter of power one of the momentous factors in the design of warships. This increase in speed is, of course, due almost entirely to the advent of the water-tube boiler and the steam turbine.

In the matter of armament, the all-big-gun feature is still the predominating one in capital ships, and the endeavor to so mount these guns as to give the greatest possible broadside fire has led to the almost complete abolishment of the superstructure and a return to clear decks. The most striking feature of the modern armament of a war vessel is its greatly increased destructive power. The modern 12-inch naval gun is now effective at the maximum battle range which would be possible under normal conditions, and the high velocities achieved with this gun, together with the ease and rapidity with which it may be handled, have served to establish it very firmly as the main defensive naval weapon. That some advantage might be gained by using a gun of larger caliber is not denied, since a 13.5 or a 14 inch gun firing projectiles weighing respectively 1,250 pounds and 1,400 pounds would make vastly more destructive weapons. Furthermore, since a lower muzzle velocity can be used in such a gun the life of the gun is materially increased, and it is claimed that with the 14-inch gun, which has been designed for the United States Navy, the gun will be serviceable for about 300 discharges whereas the present 12-inch gun has to be relined after 80 or 100 discharges. The use of a larger gun would be a logical development in the modern battleship and is to be expected.

As to the placing of the main battery on a battleship three ideas seem to prevail, which may be termed the English, American and German. In practically all of the English *Dreadnoughts* the midship turrets are placed *en echelon* on either beam, with an opportunity for the guns of each turret to be trained on either broadside. In American designs all of the 12-inch guns are placed on the center line of the ship and all can be fired on either broadside. The German design, however, provides for turrets on the center line forward and aft and four turrets amidships, one on each quarter. These turrets are masked by the superstructure amidships, so that the guns can be trained on the single broadside only.

Considerable difference of opinion exists with regard to the secondary armament of battleships. England has taken the lead in discarding intermediate calibers, but this step has not been universally commended by designers of other navies. Satisfactory positions for the small guns are hard to find and the proof of an engagement is needed to settle this.

### Progress of Naval Vessels.

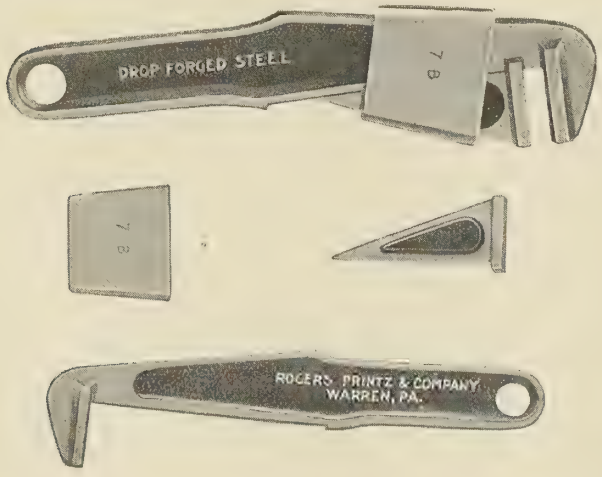
The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

| | Tons. | Knots. | | Dec. 1. | Jan. 1. |
|---|---|---|---|---|---|
| **BATTLESHIPS.** | | | | | |
| Delaware | 20,000 | 21 | Newp't News Shipbuilding Co. | 98.0 | 98.5 |
| North Dakota | 20,000 | 21 | Fore River Shipbuilding Co. | 97.5 | 98.0 |
| Florida | 20,000 | 20¾ | Navy Yard, New York | 42.3 | 46.4 |
| Utah | 20,000 | 20¾ | New York Shipbuilding Co. | 54.3 | 58.2 |
| Arkansas | 26,000 | 20½ | New York Shipbuilding Co. | 3.2 | 8.0 |
| Wyoming | 26,000 | 20½ | Wm. Cramp & Sons | 1.7 | 6.0 |
| **TORPEDO-BOAT DESTROYERS.** | | | | | |
| Lamson | 700 | 28 | Wm. Cramp & Sons | 94.8 | 98.1 |
| Preston | 700 | 28 | New York Shipbuilding Co. | 99.7 | 100.0 |
| Paulding | 742 | 29½ | Bath Iron Works | 53.5 | 59.8 |
| Drayton | 742 | 29½ | Bath Iron Works | 46.8 | 54.3 |
| Roe | 742 | 29½ | Newp't News Shipbuilding Co. | 68.8 | 70.8 |
| Terry | 742 | 29½ | Newp't News Shipbuilding Co. | 68.4 | 70.7 |
| Perkins | 742 | 29½ | Fore River Shipbuilding Co. | 64.0 | 64.8 |
| Sterrett | 742 | 29½ | Fore River Shipbuilding Co. | 62.6 | 64.4 |
| McCall | 742 | 29½ | New York Shipbuilding Co. | 37.5 | 42.1 |
| Burrows | 742 | 29½ | New York Shipbuilding Co. | 37.5 | 42.1 |
| Warrington | 742 | 29½ | Wm. Cramp & Sons | 55.6 | 58.0 |
| Mayrant | 742 | 29½ | Wm. Cramp & Sons | 56.5 | 58.8 |
| Monaghan | ... | .. | Newp't News Shipbuilding Co. | 4.7 | 7.4 |
| Trippe | ... | .. | Bath Iron Works | 11.8 | 13.5 |
| Walke | ... | .. | Fore River Shipbuilding Co. | 7.9 | 9.9 |
| Ammen | ... | .. | Fore River Shipbuilding Co. | 10.4 | 10.9 |
| Patterson | ... | .. | Wm. Cramp & Sons | 5.1 | 6.7 |
| **SUBMARINE TORPEDO BOATS.** | | | | | |
| Snapper | ... | .. | Fore River Shipbuilding Co. | 99.3 | 100.0 |
| Salmon | ... | .. | Fore River Shipbuilding Co. | 87.2 | 90.4 |
| Seal | ... | .. | Newp't News Shipbuilding Co. | 30.8 | 34.1 |
| Carp | ... | .. | Union Iron Works | 27.4 | 35.6 |
| Barracuda | ... | .. | Union Iron Works | 27.5 | 35.3 |
| Pickerel | ... | .. | The Moran Co. | 23.1 | 32.0 |
| Skate | ... | .. | The Moran Co. | 23.1 | 32.0 |
| Skipjack | ... | .. | Fore River Shipbuilding Co. | 11.1 | 13.6 |
| Sturgeon | ... | .. | Fore River Shipbuilding Co. | 11.1 | 13.5 |
| Tuna | ... | .. | Newp't News Shipbuilding Co. | 9.9 | 12.3 |

## ENGINEERING SPECIALTIES.

### Arpeco Wrenches.

A new and extremely simple wrench is being placed on the market by Rogers, Printz & Company, Warren, Pa. These wrenches, as shown by the illustration, consist of only three pieces, and operate on the wedge principle. The three parts are the main handle bar, the shank or the lower jaw and the

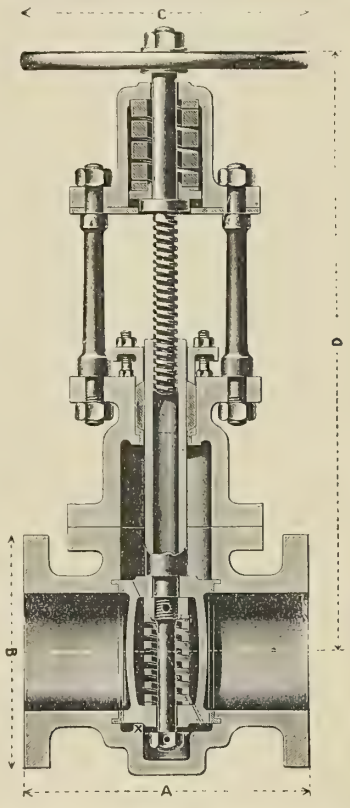



yoke or sleeve. The main handle is made from specially tempered drop-forged steel in the form of an I-beam, which not only gives unusual strength but also affords a good grip for the hand. The lower edge is also drop-forged steel of the same special quality and temper. The yoke or sleeve is cold drawn from specially made fine quality seamless steel tubing. The operation of the wrench is clearly apparent from the illustration. It is simply necessary to raise or lower the yoke or sleeve by the thumb of the hand which holds the tool, and a powerful grip can be obtained.

### Turnbull's Patent, Excelsior, Parallel, Slide, Full-Bore Valve.

The valve illustrated, which is manufactured by Alexander Turnbull & Company, Ltd., Bishopbriggs, Glasgow, is claimed to give positive closing or shutting off of the steam at both the inlet and outlet faces.

The positive closing is obtained by forming the valve block in halves, constituting oppositely inclined planes sliding upon each other in dovetail grooves, thus introducing a wedge action when closing. The outlet half is secured to the spindle, leaving the inlet half free to move, due to the expansion of the spring until brought up by the nut at the end of the spindle. When in any but the closed position the two halves of the valve block are kept fully distended between the shoulder on the spindle




and the nut, due to the expansion of the internal spring (made of special non-corrosive metal), thus reducing the width of the block sensibly less than the distance between the seat faces. It is claimed that the internal spring, acting along the line of the valve spindle, and not at right angles to the valve faces, does not set up any abrasive or wearing action on the seats or faces. In closing, the block travels down until, when opposite its seat, the inlet half comes into contact with the stop, then the continued downward movement of the spindle and outlet half acting against and compressing the spring, sets up the wedge action, which positively closes both faces of the valve. In opening, the least upward movement of the spindle and outlet half of the block is assisted by the upward thrust of the spring, until the nut engages the inlet half of the block, when the valve block, being less than the distance between the seats, lifts easily without friction.

### A New Reversible Marine Oil Engine.

Recently, at the invitation of Messrs. James Pollock Sons & Company, Ltd., of London, a number of the members of the Institute of Marine Engineers made a trip on a fishing vessel of the Swedish type equipped with a Bolinders reversible oil engine. The vessel was 60 feet long by 19 feet, with a depth of 9 feet. The engine was a two-cylinder, two-cycle, 80 brake-horsepower motor, with cylinders 12.99 inches diameter and

13.39 inches stroke, running at 325 revolutions per minute. This motor differs from the usual forms of reversible motors, in that the reversing action is effected by means of a valve gear instead of by compressed air. The engine also possesses the advantage in that the use of epicyclic clutches, or feathering propellers, is obviated for the ahead or the astern movements, and the engine can thus be adapted for high powers. The engine is designed to burn crude oil or kerosene (paraffin), and drives the vessel at a speed of about 8 knots. There is no separate compressor used for compressing the air for starting purposes, one of the engine cylinders serving for this purpose. The engine has a pump for providing water circulation and also a bilge pump. Forced lubrication is used throughout, and all the principal bearings have a small pump, driven from a common shaft.

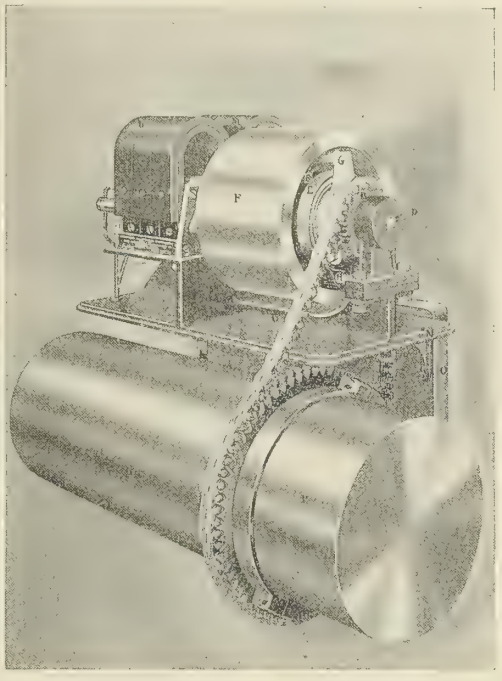
### The Hutchison Marine Tachometer.

It is a matter of importance for the captain of a steamship to be able to quickly and accurately determine the revolutions per minute of the engines ahead or astern, and to know definitely that his signals to the distant engine room are understood and being obeyed instantly and correctly. When a squadron of warships are maneuvering or cruising it is of vital importance that the signals for definite ship speeds, as ordered by the flagship, be obeyed instantly. A vessel traveling 10 knots, with 72 revolutions per minute, is not doing 10 knots at 71 revolutions per minute. Therefore, such a tachometer as shows the instantaneous value of engine-shaft rotation must be accurate within at least 1 percent, and remain accurate. Every steamer has its most economical cruising speed, and it is a matter of saving coal to keep the engines at such revolutions per minute as will conform to this. It was with a full realization of the importance of this field that Miller Reese Hutchison, an electrical and mechanical engineer of New York, designed the Hutchison Electrical Tachometer to meet and overcome the difficulties previously encountered.

The Hutchison electrical tachometer consists of a magneto having a stationary armature and stationary poles. Between the pole pieces and the armature rotates a soft iron inductor, which, by varying the flow of the magnetic lines of force through the armature winding, generates current therein, which is led to the alternating-current voltmeter (calibrated in revolutions per minute of the driving shaft) through insulated wires. All joints are soldered and taped. The permanent magnets of the magneto are made of the best German steel, carefully aged and treated, to insure permanence and constancy of magnetism. There is nothing to get out of order and nothing needing attention. The voltage of the magneto is directly proportional to the speed of its inductor up to a certain maximum, and the scale sub-divisions of the indicator are hence equal. In practice, a plurality of indicators, placed at widely separated points, may be operated from the same magneto.

The application of the electrical tachometer to ship service necessitated several modifications in design, the principal ones being (1) twin generators, so as to show *direction* of rotation as well as rate. (2) Inertia compensators for angular variation of speed of driving shaft and (3) special form of indicators. Otherwise the description of the marine type will convey a good idea of the principle and construction of this new instrument.

Referring to the illustration, *P* represents the propeller shaft. Clamped around it is the split sprocket *A*. Rotation is imparted to the driving sprocket *B* by the Morse silent chain *C*. Sprocket *B* is loose, not keyed to the generator shaft *D*, but is simply rotatively mounted thereon. Two oppositely-coiled flat spiral springs *E-E'* transmit the rotation of *B* to the fly-wheel *F*, which is keyed onto shaft *D*, one end of each spring being attached to the sprocket *B*, and the other end to the fly-wheel *F*. Any irregularity, therefore, of rotation in *Be*, caused by variations in angular velocity of shaft *P*, is smoothed out by *E-E'*, so that the rotation imparted to *F* and *D* is a constant resultant speed. The springs are protected against strain or breakage from sudden reversal of *P* by radial arm *G* engaging pin *H* attached to fly-wheel. On the inside face of fly-wheel, at the end opposite from that occupied by *E-E'*, are cut gear teeth, so arranged as to engage pinions *J* and *K*, which actuate magnetos. Pinion *K* is keyed to the inductor shaft of its magneto *M*. Pinion *J* is not keyed to its shaft, but so mounted that when direction of rotation of main shaft is "ahead" the inductor of magneto *L* is in the exact rotative relation to its armature and pole shoes as that of magneto *M*. The current from *L* is therefore in phase with that from *M*; but when *P* is reversed in rotation, pinion *J* rotates idly on the shaft of magneto *L*, until it has traveled 90 degrees, at



which point it begins to drive the magneto. The result is that the inductor of *L* assumes an exactly opposite relation to its armature and pole pieces as obtains at the same instant in *M*; hence the current from *L* is 180 degrees electrically out of phase with *M*. The magnetos have two cycles per revolution of inductor.

Two wires run from *L* and two from *M* to each indicator. When running "ahead" the circuits are in phase. When *P* rotates "astern," one circuit is 180 degrees electrically out of phase with the other.

The indicators, or voltmeters, have two coils—the moving coil to which the pointer is attached and a fixed or field coil. The field coil is connected electrically to one of the magnetos, and the fixed coil to the other. When two magnetos are in phase—that is, when the shaft *P* is running "ahead"—the deflection is to the right, and indicates revolutions per minute "ahead." When they are 180 degrees out of phase the pointer is deflected in the opposite direction, or to the left, indicating revolutions per minute "astern." The faster the shaft *P* turns in either direction the higher the voltage generated, and the greater the deflection of the pointer calibrated to conform thereto. In the indicator designed for pilot-house use there is no iron, steel or other compass-deflecting materials in its construction, and it may, therefore, be placed in proximity to the compass without affecting same. This type is also used in the staterooms of the captain and engineer, so that these

officials may tell at any instant just what is going on in the engine room.

The engine-room indicator has a very long scale and prominent pointer. It may be read from a distance of 20 or 30 feet, and when placed in line of vision of the man at the throttle enables him to bring his engine quickly and accurately up to any desired speed.

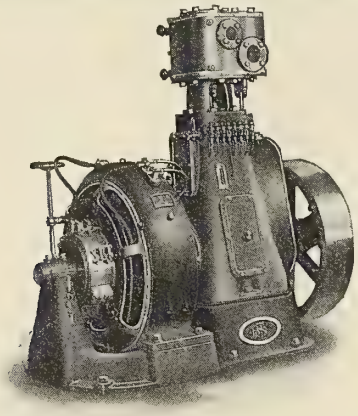
These instruments are manufactured by the Industrial Instrument Company, Foxboro, Mass. The first marine tachometer was placed on board ship about eighteen months ago, and it is claimed that it has remained untouched and in perfect calibration ever since.

### A New Generating Set.

The generating set described below is specially designed for use in isolated plants, upon shipboard and in all places where a thoroughly reliable, high-grade, efficient, quiet-running generating set is necessary. It is the latest product of the B. F. Sturtevant Company, Hyde Park, Mass.

The set consists of a generator of either the six or eight-pole type, depending upon the size, attached to the same sub-base and direct connected to the new Sturtevant vertical single engine, known as class VS-7.

This engine is of the high-speed enclosed type, the reciprocating parts being entirely enclosed within the frame, which is provided with openings through the front, back and sides, of sufficient size and in just the right position to permit ready access for inspection or adjustment. These openings are fitted

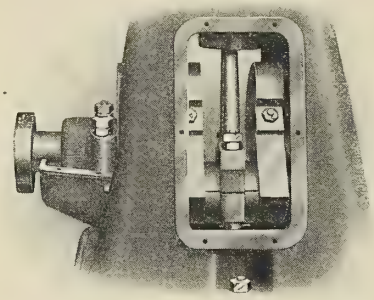


with dust-proof covers, which may be easily removed. A water-shed partition prevents the oil from the frame being carried into the cylinder and the water in the cylinder being carried into the frame. This water-shed partition, together with a piston rod stuffing box, are located in a distance piece, which separates the cylinder from the frame. Access to these parts is readily obtained through openings in the distance piece, even though the engine is in operation.

The lubricating system, of the gravity type, consists of a reservoir cast in the top of the frame, from which the oil flows to all bearings through piping equipped with sight feeds. All the oil not used flows into a reservoir cast in the sub-base. It is filtered through fine screens and forced to the top reservoir by a durable, efficient pump, located in the sub-base and entirely submerged in the oil. The engine may be run independently of the oil pump by filling the top reservoir through an opening provided in the frame, and drawing off the excess oil from the bottom reservoir through a drain cock.

A Rites inertia governor, placed in the balance wheel, regulates the speed so accurately that the variation between no-load and full-load is claimed to be not more than 1½ percent.

The generator armature is of the ironclad, two-circuit, ventilated drum type, and is pressed upon the shaft. The armature coils are form wound, and are thoroughly protected against oil and water. The commutator is made up of segments of pure, hard-drawn copper, insulated with amber mica, of such hardness that it will wear uniformly with the copper. These segments are secured in a steel ring, and insulated therefrom by rings of hard mica. Armature conductors, commutator segments and brushes are proportioned to give low-current density, thus insuring low temperature rise, high efficiency and



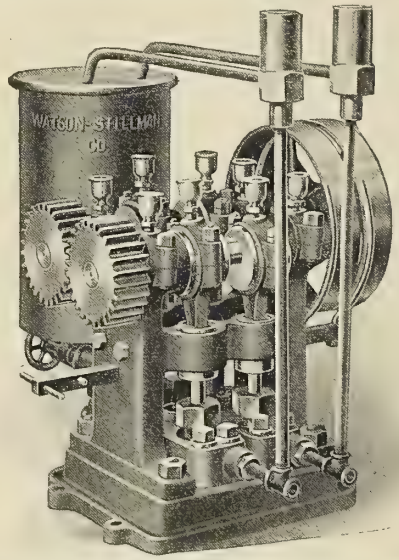
good operation. The brush rigging is arranged so that the brushes may be adjusted separately or may be adjusted simultaneously by revolving the brush ring.

The magnet frame is of cast iron, and is divided on a horizontal plane. The pole pieces are of wrought iron, and together with cast iron shoes are through-bolted to the frame. The field coils are made up in two sections, the compound winding forming one section and the shunt winding the other section. They are machine-wound and of open construction, to secure maximum radiation and ventilation.

Only the best material obtainable and the most careful and expert workmanship enter into the construction of these sets, which are thoroughly tested and subjected to the most rigid inspection before leaving the company's works.

### A Small but Powerful Hydraulic Pump.

The four-cylinder, two-pressure line hydraulic pump illustrated represents a new Watson-Stillman type, by means of which one, two, three or four pressure lines may be served




independently of each other, but from a common reservoir. Each pressure line has a separate pressure chamber, safety valve and release line, and is served by a separate pair of cylinders (½ inch diameter by ½-inch stroke) having eccentrics set to give a continuous flow. It is claimed that any pressure up to 600 pounds per square inch may be delivered into any line, the limit in each instance being determined by the setting of the safety valve, which opens as the pressure tends to exceed the limit and lets the surplus liquid pass back

through the release pipe to the reservoir. Any pressure line can be thrown out of service entirely by opening the safety valve, in which instance all the liquid in that line pumps directly back to the reservoir.

The one, two, three and four-pressure line pumps are practically the same in design save for change in the length of the bedplate and the shafts to accommodate the required number of pressure chambers, cylinders, piston rods, eccentrics, etc., and may be fitted with an electric motor instead of the pulley shaft shown. These pumps are made by the Watson-Stillman Company, of New York.

## OBITUARY.

George Thompson, superintendent-engineer of the Cunard Steamship Company, Ltd., died of pneumonia at Waterloo November 30. Mr. Thompson began his business life at Belfast as a premium apprentice in the engineering works of Messrs. Harland & Wolff. After completing his apprentice-

THE LATE GEORGE THOMPSON.

ship, he gained sea-going experience, and upon obtaining his extra chief engineer's certificate he returned to Harland & Wolff's and entered their drawing office. Later he was intrusted with the important duty of supervising the erection of engines for new vessels, finally becoming works manager. In June, 1903, he entered the service of the Cunard Steamship Company, Ltd., of which he became superintendent-engineer in 1904.

### Correction.

In the last paragraph of the article describing the Sulzer Marine Diesel Engine, published on page 41 of our January issue, the cost of fuel per brake horsepower-hour should read .139d (.278 cent) instead of 139d ($2.78) as published.

**At the annual convention of the National Marine Engineers' Beneficial Association,** held in Washington, D. C., during the week of January 16, the following officers were elected for the coming year: President, William F. Yates; first vice-president, Art Hyde; second vice-president, W. P. Tindall; third vice-president, C. N. Vonsburgh; secretary, George A. Grubb; treasurer, A. L. Jones. The convention was well attended and proved a success in every way.

## TECHNICAL PUBLICATIONS.

**Accounting Every Business Man Should Know.** By E. E. Garrison. Size, 5 by 7¼. Pages, 188. New York, 1909: Doubleday, Page & Company. Price, $1.20 net.

The aim of this work has been to lay bare to business men the whole structure of modern accounting from foundation to summit. Simply and briefly the author explains the principles of business operation and finance and clears away all obscurities. The author is well qualified through an extended and varied business experience to deal with the subject in the most thorough manner. It is undoubtedly true that this subject has been little understood by many men whose business relations demand an intimate knowledge of the subject, and this merely from the fact that the real values and purposes of accounting are hidden in a multitude of details and obscurities. Great length and much detail are avoided in this volume, but the treatment is complete and very clear. It is a book which every business man should find of value.

**A Text Book of Navigation and Nautical Astronomy.** By Capt. A. P. W. Williamson, F. R. G. S. Size, 5½ by 8½. Pages, 387. Figures, 163. London, 1909: J. Griffin & Company. Price, 7/6 net.

This book is a complete and reliable text-book for those who are studying for the Board of Trade examinations, as well as for general students. Both elementary and advanced work are given, and the method of solving various problems is fully explained and illustrated by means of diagrams and numerous examples. After treating the entire subject of navigation and nautical astronomy as completely as possible, the author gives in an appendix a number of examination papers with answers to the questions, together with the necessary tables for solving the problems, so that the student may obtain a fair idea of the requirements of the Board of Trade examinations.

**Ship Construction and Calculations.** By George Nichol. Size, 6½ by 9¼. Pages, 330. Figures, 239. Glasgow, 1909: James Brown & Sons. Price, 10/6.

This book is timely in that it is the first one on ship construction from the press since the promulgation of Lloyd's latest rules. The book is a general one, covering most of the problems met by ship superintendents, draftsmen, and shipyard apprentices. It is distinctly practical and up-to-date. In fact there are a large number of sketches of details which are not usually included in books on naval architecture. Beginning with the simple ship calculations, which are necessary to determine the buoyancy and stability of ships, the author then goes on to discuss bending moments, shearing forces, stresses and strains. This subject is gone into very thoroughly and a large number of curves of loads, shearing forces and bending moments are given for ships in various stages of loading. A large part of the book takes up various types of cargo steamers, and it is in this part that most of the details of construction are given. The latter part of the book contains such matter of value to a navigating officer, so that he may properly manage his vessel afloat. Calculations for stability, trim, rolling and loading and ballasting are given in detail.

## SELECTED MARINE PATENTS.

*The publication in this column of a patent specification does not necessarily imply editorial commendation.*

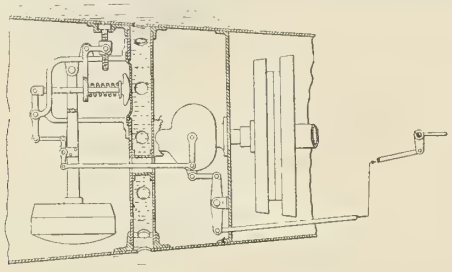
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

919,014. EJECTOR FOR SHIPS' ASHES. LUDWIG HOCHSTEIN, OF NEUMÜHLEN-DIETRICHSDORF, NEAR KIEL, GERMANY.

*Absract.*—This invention relates to those devices for ejecting ashes for ships which are operated by high pressure water or the like and the present novelty consists in branching the ascension pipes of the ejector toward both sides of the ship. At the branching point there is arranged a switching device by which one or the other of the branch pipes may be closed off as desired. Five claims.

933,083. DIVING GEAR FOR SUBMARINE BOATS. FRANK M. LEAVITT, OF NEW YORK, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

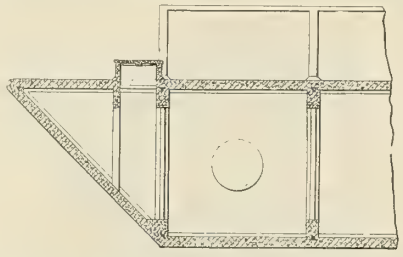
*Claim* 1.—A diving gear comprising hydrostatic controlling means, a source of power, a rudder and an interposed steering mechaism com-



prising a power-controlling device, controlled from said hydrostatic means, and a driven part connected to the rudder and propelled progressively by said power in either direction under control of said power-controlling device. Twelve claims.

933,314. CONCRETE SCOW. OSCAR F. LACKEY, OF BALTIMORE, MD.

*Claim* 4.—A boat comprising a concrete hull, a metal frame reinforcing the said hull, a plurality of concrete bulkheads provided within the hull, a plurality of compartments formed thereby, a deck formed



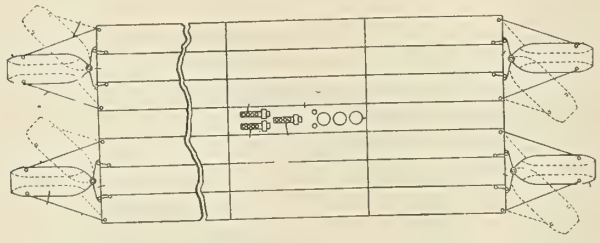
integral with the said hull, a plurality of ribs extended longitudinally of the said hull and deck, a plurality of posts formed at the juncture of the said bulkheads and ribs forming supports for the said deck. Six claims.

934,192. TORPEDO-TUBE. CESARE LAURENTI, OF SPEZIA, ITALY, ASSIGNOR TO SOCIETÀ ANONIMA FIAT-SAN GIORGIO, OF SPEZIA, ITALY.

*Claim* 3.—In combination with a torpedo tube, a cover for the mouth of the same, a connecting rod connected at one end to said cover, a traveling threaded member connected to the opposite end of said rod, and a fixed threaded member for actuating said traveling threaded member to move said rod to open and close the tube. Four claims.

936,336. SYSTEM OF RIVER TRANSPORTATION. JULIUS S. LANE, OF BROOKLYN, N. Y., AND JOHN L. MATHEWS, OF BILLERICA, MASS.

*Abstract.*—The invention consists in the combination with a gang or fleet of barges rigidly attached to each other, of propelling auxiliaries or



units flexibly, yet firmly, attached to the gang in such a way as to attain their greatest efficiency, these auxiliaries being so arranged as to be capable of changing their direction with relation to the axis of the fleet, the power, speed and direction of propulsion, and the heading of the auxiliaries being each independently under the control of the pilot of the fleet from a central pilot house. Twelve claims.

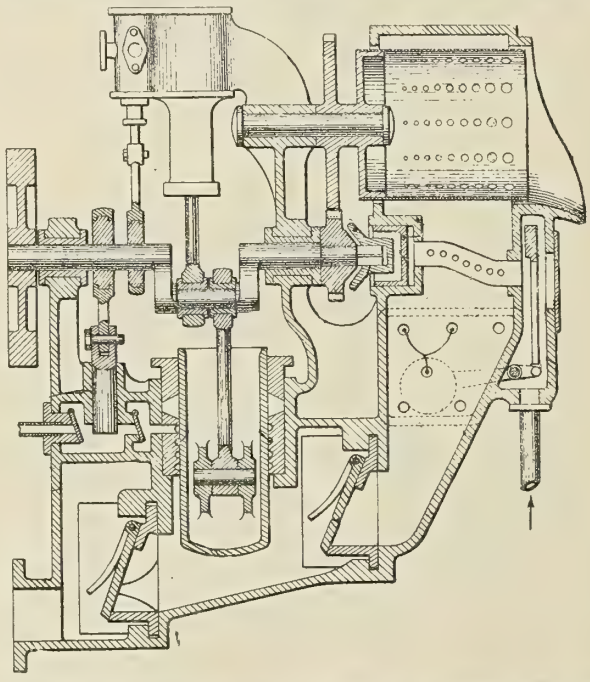
935,413. LOCK FOR DAVITS. WILLIAM J. RYAN AND LEWIS TANNING, OF NEW YORK, N. Y.

*Claim* 1.—The combination of a revoluble davit stem, a member mounted thereupon and provided with a slot; a dog provided with a portion for entering said slot in order to hold said member and consequently to hold said davit stem, and means controllable at will for shifting said dog from one position to another. Seven claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 4 South street, Finsbury, E. C., and 21 Southampton building, W. C., London.

6,513. ASH-REMOVERS FOR SHIPS. H. THIRION, PARIS, FRANCE.

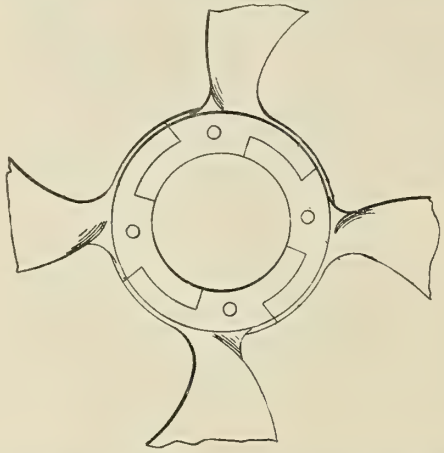
The ashes are admited through perforations in the drum into a mixing chamber for the purpose of mixing with the spent fuel and water, when the said drum is revolving. The mixing is automatically regulated by the pressure of the water, which flows through pipes into



the tank. This pressure acts on the piston and maintains the parts coupled and revolves the drum. When the flow of water diminishes the pressure on piston is reduced, the drum stops and the quantity of ashes admitted to the mixing chamber cannot exceed that of water. An auxiliary pump is provided which feeds water through the ring into the cylinder.

1011. CONSTRUCTION OF PROPELLER-BLADE CENTERS AND ADAPTABLE TO ALL CLASSES OF PROPELLERS FOR OCEAN-GOING PURPOSES. W. H. IRELAND, HANDSWORTH, BIRMINGHAM.

According to this invention, propellers are so constructed that any one of the blades and its part of the boss can be readily removed when



required, and for this purpose the boss is built of segments, to which the blades are cast direct. The segments are provided with flanges adapted to engage with the flanges on the adjacent segments, bolts passing through the overlapping flanges to secure the sections.

19,293. CONSTRUCTION OF BOATS AND SHIPS. W. H. FAUBER, NANTERRE (SEINE), FRANCE.

In hydroplane boats, the members constituting the bottom of the hull, and which incline downwardly laterally towards the keel line of the boat, are made greater in front than in the rear. The forward hydroplane members merge into a keel having a centerboard effect.